State of the Lakes Ecosystem Conference 2000

Conference Proceedings

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State of the Lakes Ecosystem Conference 2000 Conference Proceedings

1. Introduction

1.1 What is SOLEC?

The State of the Lakes Ecosystem Conferences (SOLEC) are hosted by the U.S. Environmental Protection Agency and Environment Canada on behalf of the two countries. These conferences are held every two years in response to a reporting requirement of the binational Great Lakes Water Quality Agreement (GLWQA). The conferences are intended to report on the state of the Great Lakes ecosystem and the major factors impacting it, and to provide a forum for exchange of this information amongst Great Lakes decision-makers. These conferences are not intended to discuss the status of programs needed for protection and restoration of the Great Lakes basin, but to evaluate the effectiveness of these programs through analysis of the state of the ecosystem. Evaluation and redirection of programs are addressed through other means and conferences. Another goal of the conferences is to provide information to people in all levels of the government, corporate, and not-for-profit sectors who make decisions that affect the Lakes.

The conferences are the focal points of a process of gathering information from a wide variety of sources and engaging a variety of organizations. In the year following each conference the Governments prepare a report on the state of the Lakes based in large part upon the conference process.

The first conference, held in 1994, addressed the entire system with particular emphasis on aquatic community health, human health, aquatic habitat, toxic contaminants and nutrients in the water, and the changing Great Lakes economy. The 1996 conference focussed on the nearshore lands and waters of the system where biological productivity is greatest and humans have had maximum impact. Emphasis was placed on nearshore waters, coastal wetlands, land by the Lakes, the impacts of changing land use, and information availability and management. For both conferences ad hoc indicators were chosen and, based on expert opinions, subjective assessments were provided as to the conditions of the Lakes, lands or the stresses on the ecosystem in terms of good, fair, poor, etc.

The indicator development process became more regimented for SOLEC 98 with the development of a comprehensive suite of easily understood indicators which objectively represent the condition of the Great Lakes ecosystem components (as called for in Annex 11 of the GLWQA). The goal is to use these indicators every two years to inform the public and report progress in achieving the purpose of the GLWQA: *to restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin Ecosystem*, thus initiating a regular and comprehensive reporting system. The suite of SOLEC indicators would reflect conditions of the whole Great Lakes basin and its major components (a general system-wide overview), and they would draw upon and complement indicators used for more specific purposes such as Lakewide Management Plans (LaMPs) or Remedial Action Plans (RAPs) for Areas of Concern. During SOLEC 98 and afterward the suite was thoroughly reviewed and general consensus was obtained that the suite of 80 indicators was necessary and sufficient.

1.2 Purpose of SOLEC 2000

Following the general acceptance of the SOLEC suite of indicators was the movement to begin implementing them. The challenge was to see how many of the 80 indicators could be reported on at SOLEC 2000. In some cases this was a fairly "easy" task - data were already available for use in reporting on an indicator (by various agencies). In other cases this task becomes more difficult as new data may be necessary before we can report, or further research and development will be required before we will be able to implement data collection efforts and then report on an indicator. There was opportunity at SOLEC 2000 and through winter 2001 for further review of the Indicator List with revisions being made as conditions warranted.

At SOLEC 2000 the organizers were very pleased to be able to report on 31 indicators. Shortly after SOLEC, reports for two more indicators were added.

1.3 Next Steps and Challenges

Although 33 indicators have had reports prepared for SOLEC 2000 and are available on-line at **http://www.on.ec.gc.ca/solec/implementing2000-e.html**, we are still at the beginning of the indicator process. SOLEC 2000 was a *demonstration* of how reporting out on the health of the Great Lakes basin ecosystem *could* work.

At the time of the conference, no agency or organization had formally taken ownership of any indicator, i.e., to accept responsibility for data collection, analysis and reporting. This is a crucial step, however, in order to ensure that the Great Lakes community is committed to making the indicator process work for SOLEC. Following the conference, some key agencies and organizations have accepted the challenge of ownership. For example, a team from U.S. Fish and Wildlife Service and the U.S. Geological Survey have identified which indicators their agencies should own and to which ones their agencies could contribute, and a process was established for seeking approval by upper level administration. The Council of Lake Committees, working with the Great Lakes Fishery Commission, has also agreed to lead the reporting effort for the fishery-related indicators.

Some other important next steps include: 1. Determine who will do the necessary research for the "new" indicators, 2. Determine who will collect and maintain the data for each indicator, and 3. Determine when they will start. However, it is recognized that these steps will require resources to move ahead.

Another step in the process will be trying to compile certain groups of indicators together into indices, so that instead of reporting out on 80 separate indicators, eventually we would be reporting out on 10 to 20 indices. Two examples, the "fishability index" and the "coastal wetland index" were presented at SOLEC 2000 and discussions held in the breakout sessions are included in these Proceedings.

2. SOLEC 2000 Highlights

Conference Results

Real data

This was the first SOLEC to present data on the indicators from the suite in order to determine the state of the Great Lakes ecosystem. This move beyond the previous "ad hoc" approach to reporting was strongly supported by participants. It also reflected the ongoing efforts of SOLEC to improve the reporting process and be responsive to the feedback and advice received from participants. With a list of indicators "on the table", many individuals, agencies, and organizations from around the basin worked to identify how their efforts could contribute to, and benefit from, SOLEC efforts.

A link between SOLEC, LaMPS, and RAPs

This SOLEC showed a strong link between LaMP, RAP, and SOLEC work. This conference encouraged discussions and comparisons of indicator work at three levels - local, lake and basin-wide.

Tangible tools for "making things happen"

SOLEC participants include experts in "making things happen" - experts that shared their advice on how to start and sustain an initiative. Key success factors identified included: finding common values among different groups of people; identifying a range of benefits that come with environmental protection; engaging small community groups by identifying what appeals to them – and building on it; developing objectives that are clearly understandable; getting the private sector involved; letting people "do their own thing", without adding bureaucratic layers; recognizing that "resources" means more than money (it includes leadership, volunteers, technical expertise and partnerships); and taking advantage of local government partners.

SOLEC Process

Broader participation than ever

This SOLEC fostered a real sense of Great Lakes community. Participation was broader than ever before – including a strong Aboriginal presence. There was a recognition that knowledge involves more than just western science. Focus on the success of local initiatives illustrated and inspired participants, and highlighted the fact that efforts to preserve and restore the Great Lakes will only succeed if we work together in partnership.

Conference delivery – a collective effort

The agenda for SOLEC 2000 was designed and delivered by more than just federal agency participants. More than ever before, SOLEC discussion topics and presentations were identified and delivered by key stakeholders from throughout the basin. This reflected the value of the SOLEC process to other organizations and initiatives – who recognize the conference as an opportunity to gain valuable feedback and advice on their activities.

Keep the discussion going – people want to stay in touch

SOLEC participants want to keep talking between SOLEC conferences. There was a call for a mechanism or forum to enable this dialogue. Participants are also interested in bringing data to SOLEC, and would like to see a system set up to contribute that data.

New and Emerging Issues

Biodiversity Investment Areas – a concept embraced

Participants showed their enthusiastic support for the Biodiversity Investment Area approach, and enhanced the systematic approach to identifying and characterizing BIAs.

The Great Lakes index concept – an open question

Feedback on the Great Lakes Index idea varied – from those who think it's an important communication tool for general audiences (the public, politicians), to others who believe the effort is too early, and that there are dangers when the state of the Great Lakes ecosystem is oversimplified. Opportunities for additional thinking include exploring the possibility of geographic (e.g. lake or river) or "thematic" (e.g. fish-food web relationship) indices. Testing the concept was also suggested.

New indicators identified

A set of preliminary indicators were identified to help understand the effects of the Great Lakes environment on Great Lakes society. Societal indicators included: economic health, sustainability of resource-based economic sectors, drinking water, public access to water bodies, human health and reproduction, and the health of eagles. A need for upstream "on land" indicators (e.g. forestry) was also identified.

3. Conference Opening

deyoihwadogęhdǫ́h	ganǫhǫ́nyǫhk
short version	*thanksgiving address*

nę:dah	nigękyǫhgoʼdę́	ęswathǫhsi:yǫ́hs	gaihwagę:gǫ́h	awá:dǫʼ
now this	*assembled crowd*	*you will all listen*	*to my responsibility*	*it has become*

né:ʼ	hędwaihwakyę́:to	shǫgwayadihaʼǫ́h	sǫgwa:wí:	ganǫhǫ́nyǫhk
it	*we will pull from*	*our creator*	*he has given us*	*thanksgiving*

ne:ʼné:ʼ	ǫ:ʼwe:sáhtʼ	sgę:nǫ́ʼ	dwęnǫhdǫ́nyǫh
it is	*rejoiceable*	*of well being*	*we are in mind of*

ne:ʼdiʼnę́ʼ	ędwe:hék	i:ʼhyá:ʼ	sgá:t	ędwayę́:ʼ	ogwaʼnigǫ́ha
and so	*we will in thought*	*we first*	*as one*	*we will put*	*our minds*

sgá:t	dędwadatnǫhǫnyǫ́:ʼ
as one	*we will greet each other*

netogyę́:	niyohtǫ́k	ǫgwaʼnigǫ́haʼ
be it so	*remain*	*our minds*

da:né:ʼ	ędwa:tro:wí:ʼ	shę́h	ohwęjá:de'
now this	*we will talk*	*about*	*existing earth*

dwano:hę́ʼ	dedwanǫhǫhkwáʼ	né:	gwatǫ́h	shę́h	niyéha:ʼ
our mother	*we refer to it as*	*and*	*also*	*what*	*she holds*

ne:ʼdiʼné:ʼ	ędwe:hé:k	gwe:gǫ́h	dędwanǫhǫnyǫ́:ʼ *
and so	*we will in thought*	*everything*	*we will thank*

netogyę́:	niyohtǫ́k	ǫgwaʼnigǫ́haʼ
be it so	*remain*	*our minds*

*shę́h niyóha:'
what she holds

odwęnohgróęnyęhnǫ' wahyanéyǫ:na' otǫdǫnyáhnǫ' odahadǫ́:ni gadí:nyǫ:'
growing varieties of weeds hanging berries growing bushes growing trees game animals

ganyadaí:nyǫ gihędényǫ' ohnawaodǫ́nyǫ' ne'hni'ne' gyǫnhéhgoh
lakes streams wells and also our sustenance

né:' gwatóh shę́h dayowa:wę́nye:
and it also the circulating winds

---

da:né: ę'gwatró:wi' hodęhǫdǫ́nyǫ'
now it we will talk about his assigned duty performers

tatihsnyé:gye's shęh ohewayęnáha
they look after how much he created

ne'di'ne' ę'gwe:hék sgá:t ę'gyetinohǫ́nyǫ:'
and so we will mentally as one we will thank them

netogyę́: niyohtǫ́k ogwe'nigǫ́ha'
be it so remain our minds

---

da:né: ę'gwatró:wí sedwagowa:nę́h agányadaí:yo'
now it we will talk about our leader handsome lake

oi:howa:nę́h satrihwá:da'a:'
a great worthy commendation he had earned for himself

né:' desahaihwa:twáht shę́h nagaogwayęhę́k ohę:dǫ́: ha'węhnihsradenyǫ́:gye'
it is he who has sealed the news of how we will conduct ourselves in future days ahead

neˀdiˀnéˀ ędwe:hé:k dęsedwanǫhǫnyǫ́:ˀ sedwagowanę́h sganyadaíyoˀ
and so we will mentally we will thank him our leader handsome lake

netogyę́: niyohtǫ́k ǫgwaˀnigǫ́haˀ
be it so remain · our minds

---

da:né: ędwa:tro:wíˀ geí: niyǫgweda:gé: hadiǫhyaˀkió:nǫˀ
now it we will talk about the four people of male inhabitants

né: deyǫkhiyęˀnyadǫ́ˀ sgęnǫ́ˀ dwęnǫhdǫ́nyǫh
it is with their hands guard us well being we are in their minds

neˀdiˀnéˀ ędwehé:k dęyetinǫhǫnyǫ́:ˀ hadiohyaˀkio:nǫˀ deyǫkiyęˀnyádǫˀ
and so we mentally we will thank them heavenly male inhabitants our guardians

netogyę́: niyohtǫ́k ǫgwaˀnigǫ́haˀ
be it so remain our minds

---

da:né:ˀ ędwa:tro:wíˀ haǫhaˀgéh gaǫhyadéˀ hanagréˀ shǫgwayadíhsˀǫh
now it we will talk about him who in heaven he lives creator

ne:ˀtsǫ́: toˀsęhdǫ́h néˀ sgęnǫ́ˀ nidwęnǫhdǫ́nyǫ:ˀ
only things dropped down well being in our minds

neˀdiˀnéˀ ędwe:hé:k dęsedwanǫhǫnyǫ́:ˀ gaǫhyadéˀ hana:gréˀ shǫgwayadíhsˀǫh
and so we will mentally thank him who in heaven he lives our creator

netogyę́: niyohtǫ́k ǫgwaˀnigǫ́haˀ
be it so remain our minds

da:netóh	naga:tgwe:ní	i'géh	aguyagęhdáhk	gangǫhǫ́nyǫhk
this is the best	*I could do*	*up to me*	*it came out*	*thanksgiving*

da:nétoh
that is all

Address and Cayuga-English translation provided by
Norman L. Jacobs
Haudenosaunee Environmental Delegate
Six Nations of the Grand River

3. Conference Opening (con'd)

Sharing the Haudenosaunee Perspective of the Great Lakes Environment - Norman Jacobs (Haudenosaunee Environmental Delegate)

It is my responsibility to welcome the participants with special thanks to Harvey Shear, Paul Horvatin, to SOLEC 2000 and the Six Nations Territory. You have just experienced a small part of Haudenosaunee culture and tradition on how we relate to the natural world. We give thanks, as I have, at every meeting and every council. Thanksgiving is not just an exercise in spirituality. It is relevant to each of the matters that we are gathered here to consider.

In the past, and even today there are deliberate policies by the Canadian and the United States Governments to destroy our way of life, our culture and traditions.

Therefore the Haudenosaunee Environmental Delegation **without prejudice** reluctantly makes this submission to the State of the Lakes Ecosystem Conference (SOLEC) 2000. The Two Row Wampum Treaty forbids our interference in each other's Governments laws. However the continuance to inadvertently affect our well being and way of life by continuing to disrupt and destroy the earth and the life it supports forces our participation. We must stand and speak for we have silently stood by and watched the pilfering and plundering of earth's natural resources for too long. We stand here offering our hand in friendship to share our knowledge and ideas.

Our leaders in making decisions of law must carefully weigh what impact that decision will have on **future generations, the environment and the natural world.** We believe that everyone in public office should think this way. Not what is good for us today or what will get them elected again. Our legal and political structure was designed to endure. It was designed to spread, to bring Peace to the World within the **Great Peace** and to do so with the persuasive power of the **Good Mind**. It is the combination of these powers, the good mind and the great peace working together, in balance that creates a unity of the minds. They are interdependent. To work, they must work together.

Our leaders are chosen for long service, because someone whose mind is on his next election cannot properly consider the needs of the generations to come. A good mind, working properly, will seek peace, protect peace, and maintain peace. And peace is the beginning of law, and the foundation of governance.

I tell you this, the smallest insect, the tiniest tree, the mighty maple has a right to survive in this world, to survive with their brother humans. It does not matter how few they are or how far up the food chain they are for each of our brothers that is lost, that is destroyed or exterminated is a loss for the entire world, upsetting the balance of nature that is gone forever. That is what our law teaches.

I do not believe that it is necessary to embrace the global economy in order to live a good life in this world.

I believe that the quality of life is not dependent on a standard of living.

I believe good people, caring for each other was the way of the past and is the way of the future.

Our lands are becoming the last refuges of the natural world, of the animals and plants we depend upon. The natural world of which we are a part and which we bear special obligations. Usually, this is viewed as being closer, a part of nature rather than standing against it. Not on some holy mission to exploit or dominate it.

Today, the natural world continues to struggle to survive, but with a message to the nations of the world it is time to slow down, to care for one another instead of seeking wealth for the few, **to care for Mother Earth** instead of our own pleasures. We are taught that we have rights, rights that are balanced by responsibilities to the natural world as well as to the future generations of the world.

Some non-natives and their government's agencies lead us to several conclusions about the Great Lake Water and they are;

1. They consider environmental factors too little.
2. They consider economic factors too much, leaving too much to chance.
3. We have no right to interfere unduly with the animals and fish that make water their home. Unless there is a demonstrable and pressing need for humans to change any part of its ecosystem, **we must leave it alone**.
4. Though waters have a capacity to heal themselves and to deal with limited amounts of waste, especially organic or natural waste, we have an obligation to prevent the placing in the water poisons, and a duty to limit the natural wastes that are put into the water.
5. Over time the lakes, streams, and rivers have been used as a sewer for human, agricultural and industrial waste. It is part of our obligations as the custodians of the natural world (water) to lead in helping the life it supports. Which means that we must seek a future economic base that respects and does not pollute the water.
6. This is a small world we live in. More than ever, we recognize that what we do in one place has its effects in may other places. We see this in the globalization of business, in the turmoil of politics, we see it above all, in what we are doing to the environment.
7. That they have a separate agenda and that is to sell Great Lakes water in bulk, which we can never, nor will ever agree to.
8. That each scientist will interpret the data collected and give a report which contradicts the others' statement.

Let us now look at what is termed **scientific indicators**. Does it matter whether it can be scientifically proven that human life on earth is in danger? If that possibility exists we cannot afford to ignore that possibility. While SOLEC monitors, gathers information, enters data, strikes committees and prepares budgets, the destruction and desecration of Mother Earth and life as we know it continues. We ask you not only to trust scientists (and what can be scientifically proven), but listen to the wisdom of the people that have lived here since time immemorial.

At this time let me relate to you our oral prophecies which have been passed down since time immemorial - we were told that:

- That trees would died from the top down
- That water would burn
- That we would have to go a long way for water
- That water would be so dirty you could not see the bottom
- That animals thought extinct would reappear
- That birds what once nested on the ground would now nest in trees
- That women past child bearing age would once again bare children
- That there was a web around the world

- That in the future that web was going to rip
- That when that happened there would be chaos storms, floods and high winds

These prophesies came from our ancestors a long way back with no specific date which we take as warnings of things to come. Warning to us, indicators to this group, as to the health of Mother Earth. We must take heed of these as you all know we have seen many of these now.

We must ensure that the natural values and fragile ecology of lakes, streams, and rivers are restored and protected. Protected for the future generations. The Natural World, gifts from the CREATOR are not a commodity, which can be bought and sold.

4. Plenary Presentation Summaries

The plenary presentations at SOLEC 2000 covered many topics and involved many presenters (29 presenters in total at the plenary sessions). One over-riding focus of the presentations was indicators of course, and the use of indicators at three different scales.

1. The first day looked at the state of the whole Great Lakes basin using the results of implementing 31 of the 80 indicators discussed at SOLEC 98. There was also a focus on human health, with more detailed presentations on three indicators - swimming advisories, drinking water quality and fish consumption advisories. In addition to applying indicators, there was a presentation about the development and use of indices. Presenters were recognized experts in the fields, not necessarily people involved in the SOLEC indicator process.

2. The second day had a local perspective beginning with a presentation on the integration of the Biodiversity Investment Areas, then looking at how indicators are put to use on a smaller scale. The case studies presented included Hamilton Harbour, Chicago Wilderness, the Marsh Monitoring Program, the Alvar Initiative, and the Wild Rice Program. Presentations on the second day also recognized some of the great restoration and rehabilitation work taking place in the Great Lakes basin: Ontario's Environmental Farm Plan, Saginaw Bay Watershed Initiative Network, the Rural Water Quality Program in the Regional Municipality of Waterloo, Ontario, Ontario Power Generation's Carbon Sequestration and Biodiversity Management Program, Tip of the Mitt Watershed Council, Xerox, and Hamilton Harbour Remedial Action Plan. All of these presentations were made by people who are closely involved in this work.

3. The third day looked at the individual Great Lakes and how indicators are used. The St. Lawrence River presentation focused on biodiversity and non-native species, the presentation on Lake Ontario looked at lake trout rehabilitation as well as indicators, while the rest of the Lakes and the St. Clair-Detroit corridor presentations looked at the state of the ecosystem. Lake Michigan also discussed the state of the fishery. Presenters were people closely involved with the individual LaMPs.

The majority of these presentations can be viewed at **http://www.epa.gov/glnpo/solec/2000/day1** *or* **http://www.on.ec.gc.ca/solec/solec2000e-html**

5. SOLEC 2000 Breakout Session Summaries

5.1 Indicators & Indices

Open & Nearshore Waters #1

Facilitator: Vicki Thomas, U.S. Environmental Protection Agency
Recorder: Robert Beltran, U.S. Environmental Protection Agency
Number of Participants: 39

Highlights of Indicator Discussions:

1. Indicators need to be customized / reported independently for each Great Lake. Need to have objective for indicators. Some indicators are too narrow in scope (for example, DELT needs to cover more than one fish species in one lake).

2. Need habitat / exotics indicators for open lake, nearshore, wetlands, fish / aquatic ecosystem. Need to bring the private sector (i.e., industry) plus non-government organizations and universities into process, including data sharing.

3. Management vision needs to be clarified for:
   1. nutrient loading
   2. native vs. stocked species (planted)
   3. definition of preyfish - natives vs. exotics

General Indicator Discussion:

- Walleye have more and better data available for abundance than for harvest.
- Why wasn't reporting on salmon and trout done?
- Some indicators have very sketchy data - scuds, for instance. Also, no data on Lake Superior north shore sea lamprey populations.
- The phytoplankton information used needs to be integrated with data sets from other agencies.
- Additional sediment core data exists for Lakes Superior and Michigan.
- Wastewater Pollutant Loading indicator (#7059) - an explanation is needed as to why this indicator is considered a Tier 3 indicator. Data exists to move this into Tier 1.
- Why does the indicator on Contaminant Exchanges (#120) need to be detached from indicators # 117-119? All of these processes are encompassed under programs such as IADN, both from the perspective of fluxes in and out of the open lakes.
- For indicator #115 (Contaminants in Colonial Nesting Waterbirds), why have sentinel species such as bald eagles been excluded? They should be highlighted not excluded.
- Extend the Phosphorus Concentrations and Loadings indicator (#111) to include a nearshore component and possibly tributaries and embayments components. This is needed in order to put the offshore phosphorus measurements into context.
- Need an indicator related to non-native species.

Highlights of Index Discussion:

1. It is good to have understandable indices that clearly express trends, but there is the danger of oversimplifying complex issues.
2. The group generally supports the idea of a data management workshop with trepidation regarding

commitment of resources.

3. Develop a public oriented pilot index for on-line and/or paper publication.

General Index Discussion:

In general, the group supported the concept of the development of indices that combine a series of indicators.

- Could develop indices by geography - i.e., nearshore vs. wetland vs. open lake vs. tributary.
- Need some indices to reflect community conditions.
- Engage decision makers and legislators.
- Develop indicator objectives.
- Develop indices on issues of "drinkability", "fishability" and "swimmability".

Open & Nearshore Waters #2

Facilitator: Vicki Barron, Credit Valley Conservation Authority
Recorder: Dan Hopkins, U.S. Environmental Protection Agency
Number of Participants: 18

Highlights of Indicator Discussion:

1. In general, the group agreed with the need/usefulness for all the indicators presented and were in general agreement about the assessments (e.g. poor, mixed, good) for each of the indicators. Notable exceptions, however, were the indicators for zooplankton and phytoplankton populations. The group concluded that these indicators are essential (necessary), but that more data is needed to make meaningful assessments.

2. The group believed that other sources of data could be tapped. They suggested that a useful vehicle for doing so was the SOLEC website. Specifically, they suggested that anecdotal information could be collected through the website and would be useful information to have (hexagenia density was used as a case in point).

3. Related to indicators in general, the group had two suggestions for improvement:
   - that the assessment of each indicator would be better described/supported with trend information and an assessment of its "absolute value" or relationship to a "threshold"; and
   - that graphics should be used to portray the data showing the spatial distribution of the information, e.g. (hexagenia recovery in Great Lakes).

Comments on Specific Indicators:

- Walleye and Hexagenia (#9). A good indicator, but it is questionable whether there is sufficient data to represent whether the conditions are "improving" or "mixed". There was a discussion about whether there were other data sources for this indicator. It was suggested that the SOLEC website be used to enable anecdotal information about hexagenia to be captured. Also, the Ontario Ministry of Environment has a group that is assessing walleye population. This group might be a good source of information in the future.

- Preyfish Populations (#17). One group member pointed out that the 'principal author' of this indicator didn't agree that preyfish are a good indicator. Others argued that it is difficult to assess the individual species constituting the indicator "preyfish" and that there is a lack of information with which to assess community or population level conditions.

Another asked, "when we talk about 'biomass', then which species are we discussing? If we're talking about salmon, then we need alewives as a primary forage base. If alewife population is low, then salmon don't do well. If we want a good sportfish population, then the relevant forage fish base is needed."

The group seemed to accept the suggestion that "changes in native preyfish" might be a better indicator, but there needs to be clarity about what (sportfish) the native preyfish is an indicator for. The endpoint needs to be better defined for this indicator to be very useful, otherwise it is too hard to characterize.

- Spawning-Phase Sea Lamprey Abundance (#18). A better measurement would be the number of lampreys or a lamprey wounding rate. The group thought that trap catches of lamprey shouldn't be dropped, but recommended adding wounding rate. Also sea lamprey population might be a good indicator of tributary condition.

- Lake Trout (#93). This indicator should include the success of native trout as well as the health of stocking success. Because both fishing pressure and lamprey are the principal sources of lake trout mortality, fishing pressure should be considered a measure for the indicator.

- DELT in Nearshore Fish (#101). DELTs are a good indicator, however, data is only available for Lake Erie. In order to report out, need more data. *This discussion led to a general conclusion that it would be preferable to have trend information and a threshold value included with the assessment of an indicator.*

- Phytoplankton Population (#109). One of the members believed that the reason the indicator measure is "uncertain" is that there is no agreed upon endpoint. The group believed that it was legitimate to include this indicator, but that there was a need for more data about it.

- Phosphorus Concentrations and Loadings (#111). The group agreed that this indicator should be included and also agreed with the assessment "mixed". *This discussion also led to a general conclusion though, that (at least for some indicators) it is better to have graphics showing spatial distribution of an indicator subject, rather than an assessment such as the word "mixed" - it's just not sufficiently descriptive to be meaningful.*

- Contaminants in Colonial Nesting Waterbirds (#115). The group believed that this indicator is necessary. They also agreed that the assessment was OK.

- Zooplankton Populations (#116). The group recognized that zooplankton population is an important indicator, however, it needs work to be useful. The group suggested that the status of this indicator be changed to "Tier 3". It was noted that there are no agreed upon endpoints or metrics. Zooplankton population is subject to fluctuations that make it difficult to establish endpoints. How should it be measured? With sufficient data, we could get useful information on conditions and trends.

- Atmospheric Deposition of Toxic Chemicals (#117). The group agreed that it should be an indicator, and agreed with the assessment for it.

- Toxic Chemical Concentrations in Offshore Waters (#118) - The group agreed that it should be an indicator, and agreed that the assessment for it was OK.

Additional Recommended Indicators:
The group identified several indicators that they felt should be included in the suite but weren't.

- Dissolved Oxygen (D.O.). D.O. was thought to likely be only an issue for the middle basin of Lake Erie. Some group members thought that D.O. should be a nearshore indicator arguing that there are local pockets and areas where D.O. is low and caused by morphology and specific sources (e.g. aqua farming such as in Georgian Bay).

- Bacterial Loading in Nearshore Waters. This indicator could be used to describe the result of loading from sources such as black/gray water, recreational boats, and aqua culture.

- Chemical Concentration in Nearshore Great Lakes Waters. The group thought this indicator could be used to describe water column conditions.

- Chemical Contaminants in Whole Fish.

Highlights of Index Discussion:
Indices might be useful provided:

- more than one are used to describe ecosystem effects;
- they have a geographic focus (e.g. Detroit area or Lake), but not used to integrate over the Lakes;
- combining of indicators are done on a "theme" basis (e.g. fish-food web relationship, pollutant loading for water quality, or trophic states);
- must know who you are communicating the value of the index to; and
- they must be defensible and meaningful. The user must understand the basis for the index.

General Index Discussion:
The question was asked "what about indicators being of the same weight within the index?"

One of the group said that it (use of an index) was an issue of resolution. He used an analogy of flying an airplane to illustrate his point. He posed the question - "if you were flying an airplane, would you be willing to have the instrument panel consist of warning light gauges to show a malfunction, or would you rather have gauges that register specific readings of barometric pressure, airspeed, etc. in order to fly the plane?"

Another participant used a different analogy, saying "if you mix grapes, bananas, apples, and pears, what do you get besides fruit salad? Is it defensible and meaningful?"

One of the participants suggested that such indices can be useful to scientists, but to be useful they must be written in a plain and understandable way. Another participant pointed out that an index can be useful, citing the example of an air quality index. "People may not understand the various parameters or indicators that comprise the index, but if they know that when the index reaches a certain level, more people are admitted to their hospital, then it can be understandable".

The group felt that to be meaningful an index had to have an appropriate geographical scope. The use of an index on a Lake-by-Lake basis might work, but they doubted whether a single index could be used to describe the condition of the entire basin. Also, if indices are used on a Lake-by-Lake basis, then you really must use more than just one index. Further, that the indices should be grouped thematically (e.g. by food web relationships, by air/water pollutant loading or air/water quality, or by trophic status). It may be hard to set endpoints.

Another participant said that indices are OK provided that they are useful for those who wish to use them. However, you really need to understand who you are communicating with and it is necessary for you to know how the index was derived. If we were to prioritize indices, then prioritize Diporeia population/condition.

The group took a vote about whether the use of indices made sense. The group split 5 yeah, 5 nay, and 2 undecided.

The last discussion captured other index (indices) work:

- University of Wisconsin, Green Bay is using clustered indicators as a tool for the RAP ("remedial action plan"). This has a geographical focus - the southern half of Green Bay;
- IBI has a large literature base; and
- Ohio uses a Lake Erie Quality Index.

Coastal Wetlands

Facilitator: Tim Henry, U.S. Environmental Protection Agency
Recorder: Dave Cowgill, U.S. Environmental Protection Agency
Number of Participants: 65

Highlights of Indicator Discussion:

1. The Great Lakes Wetlands Consortium holds much promise to fill wetlands data gaps, to develop a consistent approach to monitoring wetlands and to develop compatible data sets throughout the basin.

2. The existing data needs to be viewed within the proper context because:
   - the natural variability and fluctuations of wetlands may or may not affect apparent results;
   - the short-term nature of data sets makes it hard to draw trend conclusions, and
   - it is critical for data consolidation to create any kind of index.

3. We don't know where the "gas gauge" is. We still need more and better data as well as objective endpoints. We cannot, but should be able to, tell the story well to either decision-makers or the general public.

General Indicator Discussion:

- We need a communication strategy that parallels the development of the wetlands indicator developments.
- We need to link indicator development with the Great Lakes priority places.

Session Goal: The purpose of this session was to review the fourteen coastal wetland indicators presented in the SOLEC reports and/or conference presentations, and make recommendations on improvements, information sources, research needed, and the potential for the development and use of an index.

The indicators were critiqued, and sorted into the following categories:

Tier 1 (have data for the indicator, can report):
4504 - Amphibian Diversity and Abundance
4507 - Wetland-dependent Bird Diversity and Abundance
4861 - Effects of Water Level Fluctuations

Tier 2 (monitoring/data collection program is funded and ready to go):
4501 - Coastal Wetland Invertebrate Community Health
4502 - Coastal Wetland Fish Community Health
4506 - Contaminants in Snapping Turtle Eggs
4510 - Coastal Wetland Area by Type
4513 - Presence, Abundance and Expansion of Invasive Plants
7055 - Habitat Adjacent to Coastal Wetlands

Tier 3 (indicator needs research and/or an advocate):
4503 - DELT in Coastal Wetland Fish
4511 - Gain in Restored Coastal Wetland Area by Type
4516 - Sediment Flowing into Coastal Wetlands
4860 - Nitrates and Total Phosphorus Into Coastal Wetlands
8142 - Sediment Available for Coastal Nourishment

Points raised in this session include:
1) The importance of time as a dimension of indicators - are we measuring variability over a short period of time, or a true trend?
2) The importance of sound science in all indicators.
3) The possible use of a "keystone species" for invertebrate indicators.
4) How much data is needed (minimum) to report a result?
5) We need indicators of coastal wetland function and value, not just quantity and type.
6) Data sources should be referenced.
7) If a numerical index is used, we should include our confidence in that number.
8) Land Use Cover should be added.

Potential sources of information mentioned include:
1) The Nature Conservancy
2) U.S. Army Corps of Engineers
3) U.S. Environmental Protection Agency
4) Environment Canada
5) Sierra Club
6) National Oceanic and Atmospheric Administration
7) State Agencies
8) Canada Department of Fisheries and Oceans
9) Ontario Ministry of Natural Resources
10) Local Conservation Authorities (Canada)
11) U.S. Geological Survey
12) National Park Service (U.S.)
13) U.S. Fish and Wildlife Service
14) U.S. Department of Agriculture (Natural Resources Inventory)

15) Ducks Unlimited
16) North American Herpetile Association

General Index Discussion

Issues related to the use of an index include:

- Some indicators are "indices", others just indicators.
- With an index, you might oversimplify already simplified data. Weighting factors might be needed.
- There is a risk of people drawing their own conclusions (incorrectly) if data are not summarized and interpreted for the public.
- All indices are dangerous, because they are subject to abuse.
- An index for a given area is only good if done for a range of water levels, due to the extreme variability of coastal wetlands attributable to fluctuating water levels.
- We should consolidate our effort around the solid indicators, and build research around these.
- In communicating indicators, it is desirable to include multiple levels of detail (a "headline", a story line, and the "article").
- The SOLEC indicators are useful.
- In reporting on indicators and indices, qualifiers could be added to ranking factors (e.g., lo-med-hi, Best Professional Judgment, Established Monitoring Program, A One-Time Research project, extrapolated to a larger area, etc.).
- It is critical that we find a way to explain the findings of SOLEC to the public, so we effectively communicate to them. Otherwise, the message might be misinterpreted.

In general, there was not much support in this session for reducing an index down to a number. There was a mixed reaction to the "amoeba diagram" approach. The group tended to prefer the approach that listed indicators with color-coded shading to convey information in both a text-based and graphical manner.

The point was made strongly in this session that the binational Great Lakes Wetlands Consortium holds much promise to fill wetlands data gaps, to develop a consistent approach to monitoring wetlands and to develop compatible data sets throughout the basin.

Land (including Nearshore Terrestrial and Land Use)

Facilitator: David Smith, Lura Consulting
Recorder: Philip Gehring, U.S. Environmental Protection Agency
Number of Participants: 42

Highlights of Indicator Discussion:

1. The indicators for "artificial coastal structure" and "extent of hardened shoreline", are essentially the same and should be welded together.
   There was also concern expressed about the criteria (or lack of) for developing, selecting, negating indicators, and the need for clarification of endpoints.

2. Groundwater needs to be considered as an indicator.

3. Water level fluctuations impacts include:
   - stream flows

- impervious area (land conversion) should be added, data may be limited to 80's from NASA, no new data being generated?

4. Need more involvement between SOLEC events - i.e., Forums for getting together to continue discussions.

The first breakout session began with two brief presentations on agricultural land use programs in Canada and the United States. The presenters were Peter Roberts, Ministry of Environment, Canada and Roger Nanney, U.S. Dept. of Agriculture. Mr. Roberts discussed the Ontario Environmental Farm Plan, a voluntary program of risk assessment of farming activities. Over 15,000 Ontario farmers were exposed to the program through local workshops. Web page information is also available. The program consists of 23 modules to evaluate environmental risks in farming practices. Mr. Nanney presented a description of the Conservation Reserve Program and the voluntary Environmental Quality Incentive Program in the United States. The Conservation Reserve Program has twelve areas of activity. Some of the areas include erosion control, tillage, waste management and conservation buffers. The Environmental Quality Incentive Program helps the farmer to identify projects and practices that can be used to improve environmental impacts and some assistance in carrying out approved plans.

Discussion of indicators was limited due to time constraints and the participants having little time and/or exposure to the background materials.

Are the indicators in the set for this breakout session still necessary and sufficient? If not, what should be changed / added / deleted? :

- indicators #8131, Extent of Hardened Shoreline and #8146, Artificial Coastal Structures should be melded together into a single indicator;
- a new indicator should be developed to evaluate impacts of land use on groundwater volume and quality, particularly impacts on drinking water supplies;
- water levels and flow variations due to land use activities should also be developed into an indicator;
- the increase of impervious surfaces attributed to urban sprawl could be a key indicator.

The participants expressed a lack of understanding of criteria for establishing or removing an indicator from the suite. The use of peer review was suggested.

What research needs can you identify to further develop or implement the indicators in this set? :

- Governments must take leadership role to connect community resources.
- Define clear simple QA/QC criteria.
- Utilize volunteer monitoring resources.
- Provide "Chat Room" location for organizations to ask questions, report data, request equipment and resources, and provide for training and workshop announcements. Perhaps SOLEC could support the "Chat Room".
- A number of databases are available. A center to collect a list of the data bases and how they can be accessed is needed. Databases must also be documented for QA/QC to be most useful. The U.S. Army Corps of Engineers has data on structural armoring of lakeshore, U.S. Geological Survey has hydrological data, and the Lake Michigan Monitoring Council has data to share. Every community/county has a Five Year Plan or something similar that could be tapped.
- Biological data is very limited.

A "Position" with staff is needed, possibly 3 people to cover biotic, physical, and chemical types of databases related to land use. Another suggestion was to have a core group for land use indicators with a volunteer to work on each indicator. A forum for discussion of indicator topics should be established to provide a continuum between SOLEC conferences and to provide a base of informed individuals to work with interested conferees in the future.

Does *an* index approach make sense? :
In general the group felt the index approach made sense. There was considerable discussion of reservations for using indices. Over-simplification, loss of scientific integrity, hidden controversial issues and political bias concerns were some of the reservations expressed.

Human Health - General

Facilitator: Heraline Hicks, Agency for Toxic Substances and Disease Registry
Recorder: Carolyn O'Neill, Environment Canada
Number of Participants: 35

Highlights of Indicator Discussion:

1. Women and especially minorities, are less likely to know about fish consumption advisories in the Great Lakes basin.

2. While exposure levels are much lower now than they were 20 years ago, and the effects observed are subtler, the fish eaters study being carried out in Ogwego, NY, is replicating the Jacobsons' Michigan study findings. More time is needed to determine the long-term significance of these findings.

3. Older adults (50 +) exposed to PCBs through fish consumption are at risk for neuropsychological impairment (lower scores of verbal memory and learning).

The Agency for Toxic Substances and Disease Registry's (ATSDR) Great Lakes Human Health Effects Research Program (GLHHERP) was initiated in 1992 and is designed to characterize exposure and investigate the potential for short- and long-term adverse health effects from exposure to persistent toxic substances (PTSs) via consumption of contaminated Great Lakes fish. This research program focuses on the "eleven critical Great Lakes pollutants" identified by the International Joint Commission as well as other chemicals of concern in the Great Lakes basin. The program assesses human exposure to these toxic chemicals and associated potential health effects including behavioral, reproductive, developmental, neurologic, endocrinologic, and immunologic end points.

The ATSDR's GLHHERP have identified several human populations who may be at particular risk because of greatest exposure to Great Lakes pollutants via fish consumption. Predisposition to toxic injury in these populations can be due to behavior (e.g., degree of contaminated fish consumption), nutritional status, or physiology (e.g., developing fetuses), and other factors. These communities of concern include subsistence fish anglers, American Indians, Asian Americans, pregnant women, fetuses, nursing infants of mothers who consume contaminated Great Lakes sport fish (GLSF), young children, the elderly, the urban poor, and those with compromised immune function.

Over the past four years, the program has made significant progress in reporting and evaluating findings that address public health issues from exposure to contaminants in the basin. One primary reason for this progress is the program has focused its research efforts on assessing sensitive health outcomes in vulnerable, i.e., at-risk populations. The Human Health breakout session at SOLEC 2000 described and discussed research findings in 3 areas - socio-demographics, exposure data, and human health outcomes.

Other recent exposure findings indicate the following:

- At-risk populations in the basin continue to be exposed to PTSs;
- Body burden levels of some PTSs in at-risk populations are higher than in the general population. Body burdens for some of these contaminants are 2 to 4 times higher than those of the general U.S. population;
- Residents in the Great Lakes basin ate more fish than the 6.5g/day often estimated for the U.S. population; and
- Men consume more fish than women; men and women eat Great Lakes sport fish during most of their reproductive years.

In terms of socio-demographics, certain trends and behaviors have been identified in some of the at-risk populations. A recent survey estimated that 4.7 million people consumed Great Lakes sport fish (GLSF) in a given year; 43.9% of the respondents were women. Approximately 50% of the respondents who had eaten GLSF were aware of a health advisory for fish, and awareness differed significantly by race, sex, educational attainment, GLSF consumption level, and state of residence. For example, fish advisory awareness was greatest for the individual who is a white male with a college degree, consumed greater than 24 GLSF meals a year, and lived in either Wisconsin or Michigan. To the contrary, 80% of minorities who had eaten GLSF were unaware of the fish advisory, and awareness was especially low among women.

In addition, research indicates that fish is an essential component of the diets of minority populations and Native Americans, and their choice of fish and cooking practices may increase their exposure to contaminants in fish. When we examine exposure levels in these populations, we find a significant trend of increasing body burden with increased fish consumption.

Some of the health findings describe included the following:

- Significant menstrual cycle reductions were indicated in women who reported consuming more than 1 meal per month of contaminated Great Lakes sport fish.
- Maternal consumption of Great Lakes sport fish for 3 to 6 years was associated with reduced fecundability.
- Neurobehavioral and developmental deficits have been observed in newborns (12 to 24 hours after birth and again 25 to 48 hours after birth) of mothers who consumed approximately 2.3 meals per month of contaminated Lake Ontario fish. In these newborns the relationship between prenatal exposure to PCBs and performance on the Neonatal Behavioral Assessment Scale (NBAS) was assessed. The results indicated significant relationships between the most highly chlorinated PCBs and performance impairment on the habituation and autonomic tests of the NBAS at 25 - 48 hours after birth. No significant relationship was found between PCBs of lesser chlorination, DDE , hexachlorobenzene, mirex, lead or mercury on any NBAS performance test. The exposed newborns are now three years of age and initial test results for memory, verbal, and perceptual performance indicate their score is lower than children from mothers who consumed low amounts or no Great Lakes sport fish.
- Self-reported liver disease, diabetes, and muscle/joint pain may be associated with exposure to PCBs and other contaminants via fish consumption. PCB concentrations were significantly

associated with poorer pegboard performance in this sport fish consuming population. The pegboard performance test evaluates visual motor coordination and spatial orientation.

- PCBs and dichlorodiphenyl dichloroethene (DDE) were markedly elevated in an adult fish-eating cohort. Exposure to PCBs, not DDE was associated with lower scores on several measures of memory and learning.

Public Health Implications
There is good news. Pollutant levels in the environment have declined substantially, particularly from the 1970s and into the 1980s. More recent trends however, are less clear, indicating a possible plateau as well as an increase in pollutants from outside the basins via atmospheric transport. But overall, this is a success story of primary prevention; pollution prevention through a partnership among regulatory agencies, health agencies, and industry. They have all put technologies in place to reduce emissions into the environment. Unfortunately, that good news is tempered by the fact that body burden levels of some PTSs in vulnerable populations are 2 to 4 times higher than those of the general U.S. population. We also recognize that body burdens of key pollutants in the general population have been identified at levels that are within an order of magnitude that produces health effects in experimental settings.

Vulnerable, i.e., susceptible, populations are at risk for adverse health effects. These populations are at risk because of elevated exposures as well as possibly intrinsic physiologic sensitivity. Sufficient evidence is available to demonstrate that exposures to certain toxic substances can cause harmful health effects. Therefore, without public health interventions, strategies and risk communication efforts, future exposures will continue to harm human health.

With respect to the future, the time has come to promote the need for a strong surveillance system merged with an effective environmental contamination monitoring program. There is also a need for continuing research. Much still needs to be learned about adverse neurodevelopmental deficits in newborns, cognitive deficits and reproductive health effects in adults from exposure to PTSs. These adverse health effects as well as others need further investigation. Finally, we cannot lose sight of the fact that the benefits from fish consumption should be considered when evaluating the health implications of fish consumption. Fish provide a diet high in protein and low in saturated fats, and some studies suggest that eating fish each week is helpful in preventing heart disease.

Human Health - Swimming Advisories

Facilitator: Gary Kohlhepp, Michigan Department of Environmental Quality
Recorder: David Barna, U.S. Environmental Protection Agency
Number of Participants: 23

Highlights of Indicator Discussion *(note, this session focused on one indicator)*:

1. There is a need to develop consistent and timely monitoring methodologies and protocols with respect to sampling frequencies, methods and analytical procedures. An emphasis needs to be on developing a quantitative rapid *E. coli* assay (within 2 hours) - in order to get real-time information.

2. At this time, *E. coli* is a good indicator for "Swimmability", recognizing that other pathogens need to be considered also.

3. There is a need for additional epidemiological research to further define what is a harmful exposure and what other organisms (virus, etc.) could be considered as indicators.

4. Recognition that beach monitoring should be strongly encouraged by local entities, with funding available from state/provincial/federal support.

5. Use the U.S. Environmental Protection Agency National Survey as a starting point to summarize U.S. Beach data for SOLEC reporting. U.S. Environmental Protection Agency should be the lead agency for this indicator.

6. Index needs to be normalized to reflect the number of times the beach is monitored (number of monitoring days), so entities are not penalized for more frequent monitoring. This may require more than one type of index (specific to the beach, i.e. different weighting factors)

The session began with presentations from Marcia Jimenez, First Deputy Commissioner, Department of Environment, City of Chicago and Dr. Richard Whitman of U.S. Geologic Survey concerning a comprehensive research project conducted at a Chicago area beach. Dr. Whitman outlined the elements of the massive, yet unpublished, research project attempting to identify what are the controlling independent factors affecting *E. coli*. Extensive weekly sampling was conducted, including replicate and duplicate samples, throughout the day to document daily variations. A weather station was established and continuous monitoring of 20 parameters was performed. The research project is developing a predictive model to identify the best predictive variables. Initial results have identified six physical parameters in a predictive model yielding a relatively high predictive relationship. Ms. Jimenez concluded with a discussion on how to manage waterfront areas and how to communicate effectively health risks of swimming advisories to the public. Important elements include: identify sources of negative impact to water quality; analyze these sources and eliminate negative impacts; establish a monitoring program; team up with local health officials; establish a protocol for informing the public of health risks; and, “think out of the box”.

Reactions and comments to the Tier 1 indicator *E. coli*.

***E. coli* as a Human Health Indicator:**
- It is a useful indicator.
- There is a need to identify the relevance of *E. coli* to human health.
- Epidemiological studies are lacking.
- It’s the best indicator we have, good for prudent public policy.
- There is no ‘perfect’ indicator, so let’s get on with using *E. coli* and get focused in a common direction.

Monitoring/Sampling/Analytical Procedures:
- There is a need for rapid (within 2 hours), quantitative *E. coli* in the U.S. and other testing procedures to give decision makers timely information.
- The variability of data is affected by the frequency of sampling and time of day sampling occurs.
- Analytical instrumentation is costly. Perhaps passage of the “Beach Bill” in may expedite the development and funding of these needed analytical technologies. There is a need to “pressure” the scientific community to develop these quantitative, rapid techniques.
- There is a need to establish good, representative sampling devices and procedures.
- There is a need to establish standard operating procedures for monitoring activities in order to generate comparable data. This needs to be consistent throughout the Great Lakes basin.

- Ontario *E. coli* maximum is 100, U.S. risk number is too high.
- Basin-wide data collection is also needed (currently mainly urban beaches are monitored).
- Miles of swimmable beaches.
- Popularity of beach.
- At a lifeguarded beach the public perception is that public health is being protected. At a minimum, public beaches that are guarded (lifeguards) should also be monitored.
- There is a need to normalized beach closure days with the number of sampling days.
- The Great Lakes Beach Conference was held in Chicago, IL on Feb. 6-8, 2001 as a forum to discuss the science and technology behind beach monitoring and closure.
- What's happening at night to affect *E. coli* levels? Resuspension, reproduction, resuscitation.

Beach Management:

- Beach managers "need to know their beaches".
- There is a need to standardize and profile local beach conditions and parameters.
- U.S. Environmental Protection Agency is compiling beach management information in its National Health Protection Survey of Beaches.
- The way the survey is done is important, so is how the information is communicated to the public (which beaches are monitored and why it is important). How to best convey information to the public? Educate public - risk communication.

Who/What Entities are Involved:

- Mostly local Health Departments, Park Districts, etc. It is important to note that they have resource constraints.
- Major recreational beaches in U.S. and Canada are monitored.
- Michigan law does not require mandatory beach monitoring.
- U.S. "Beach Bill" may establish a framework for monitoring.
- There was agreement that monitoring should be done by local entities, with a requirement from higher authorities. These entities should have a public health component/authority.

What is Needed:

- There is need for a requirement that public beaches have monitoring (laws).
- Need power for 'pre-emptive' closure authority (i.e. after a heavy rainfall event).
- Build capacity/incentives for local entities to become more involved. Consider using a "star" ranking for beaches (e.g. dry cleaners 5 star program, cruise ship star rating for sewage system on ships). Possibly hook in with the Environmental Protection Agency beach survey, based on index (multiple component e.g. 5 star if you have a source control program, or a 5 star rating can mean that you're confident the County Health Dept. is certain of beach health based on excellent monitoring or another factor).

Monitoring - is more "better"?

- Some entities are hesitant to monitor more. More monitoring may lead to more closures.
- But, is it worse not to monitor? It may look bad to the public if there is no testing.
- There was agreement that governments have to set policy and standards.
- Liability needs to be considered (if one is not required to monitor and a swimmer gets sick, is a beach manager liable?)
- More monitoring may follow public pressures for access and the concept that recreational beaches are an economic benefit.

Opportunities to Address Issues:

- Implement Great Lakes Commission recommendations basin-wide. Work out monitoring protocols.
- Signing of U.S. "Beach Bill" will give states the opportunity for grant funding of programs.
- Partner with local industries for support.
- Bring issue before Great Lakes Governors – sell them on economic benefits of clean/healthy recreational beaches.
- Need for a consolidated approach, as many entities are involved.
- U.S. Environmental Protection Agency's Great Lakes National Program Office (GLNPO) funding of programs.

How Should Data Be Reported as a SOLEC Indicator?

- Use the U.S. Environmental Protection Agency "National Survey" as a basis/framework to compile/collate data.
- Need to integrate data into a riparian ecosystem approach.
- This is not an isolated issue, however it is disconnected from other environmental issues on Great Lakes. With loadings of fecal coliforms, we can infer other loadings, e.g. pharmaceuticals.
- Need to consider what *E. coli* is doing to fish, benthos. It could be part of a nearshore index tied to contaminated sediment disposal issues, animal runoff, septics, etc. May need another organizational level to address this. Maps/GIS are ways to integrate all of this data. Need to stop looking at these indicators in isolation.
- Need to identify quality of data reported (like metadata).
- Tap GLNPO as a source to fund a reporting mechanism.

General Discussion on "Index" Approach:

- One respondent stated that it doesn't make sense, the general public won't relate to scientific jargon.
- Indicators used in an overall index are based on many factors which impact its validity.
- Need to give appropriate weights to factors forming an index.
- With respect to beach closure, need to consider the number of swimming days, and the number of monitoring days.
- Consider beach-miles.
- Need to normalize with the number of monitoring days.
- A need was recognized to consider the audience for indicators/indices (public; beach managers) – there may be a need for different indicators/indices for different audiences.
- Tie in "swimmability" with other human health indicators (number of fish advisories, drinking water, etc).
- There is a need for a 'management indicator', to rank the quality of monitoring programs (e.g. are we eliminating sources?).
- Three factors for a closure/monitoring index were considered including: percent of miles monitored; percent of swimmable days, and percent of monitoring days.

Human Health - Drinking Water

Facilitator: Joanna Kidd, Lura Consulting
Recorder: Bill Spaulding, Eial Dujovny, *(both of)* U.S. Environmental Protection Agency
Number of Participants: 15

Highlights of Indicator Discussion:

1. There is not much good raw water data. A method for collecting and reporting it needs to be developed.

2. Protection of source water needs to be emphasized.

3. To get consistent monitoring, we need to standardize data collection methods and ensure data is available.

Question: Should there be a standard for raw water?
- Need to develop tool/mechanism to assess raw water e.g. U.S. Environmental Protection Agency protocol.
- Ontario Ministry of Housing - setting reporting protocol for private wells.

The discussion focused on the Drinkability Indicator (#4175) description. During the first part of this session, questions were discussed concerning the drinkability indicator. The second part of the session looked at the index approach.

What is your reaction to the write-up and presentation on the drinking water indicator?
The group was asked for its reaction to Rod Holme's presentation during the morning plenary session. Consensus was that it was a good presentation. Source water assessment and protection needs to be emphasized. States are in the assessment mode.

Before we implement protection activities we need to define source water assessment and protection areas, then do the protection.
- Sediments from dredging activities could have a significant impact on intakes and also are a possible source of contaminants.
- Some systems have problems with algae (i.e,. Bay of Quinte). Because of high algae bloom concentrations, much higher chlorine concentrations must be applied. More chlorine creates trihalomethanes which are linked to cancer in humans.
- Climate change could be another factor/concern.

The group felt that Rod Holme's presentation seemed to infer that there is not much difference between the 3 primary parts of public water: raw source water quality, treated water quality at the entry point to the distribution system, and treated water quality in the distribution system.

Drinking Water Quality
- Raw water conditions can vary widely and are generally site specific to intake locations. Some water quality is naturally better than others. Conditions can not be reliably projected to accurately reflect overall Great Lakes water quality. The mechanics of assessing overall raw water quality in the Great Lakes is difficult.
- Electricity generating stations generate heat and warm up lakes. How does this affect drinking water quality?
- Raw source water quality for drinking water systems needs to be at safe levels. Raw water quality is typically not assessed for toxic chemicals and information is not available to the public.
- According to the Michigan Department of Environmental Quality, the Saginaw/Midland public water system has chemical data and has offered it to anyone who wants it, but other agencies didn't want it or were not interested in receiving it. Available data sources should be identified and the data should be

compiled.

- River and groundwater quality data is missing. It is important to improve river water quality so that drinking water sources which are likely to be impacted by them are protected. The science of groundwater movement is poor and the interaction between groundwater and surface water needs to be more clearly understood. Should there be a protocol for reporting groundwater conditions?
- Agricultural runoff is a significant source water protection concern.
- Private wells are not covered.
- What do you monitor in raw water to adequately satisfy the public need for information and promote consumer confidence in public drinking water quality?

The existing indicator for drinking water appears to be adequate. The primary drinking water challenge for Great Lakes water systems: We need to develop a tool for assessing raw water quality and develop approaches for protecting source water quality.

How do we get consistent and regular reporting?
There is data, but the way in which water quality is monitored and reported is not consistent. A consistent monitoring and reporting format and protocol is needed.

Ontario just enacted a regulation in August 2000 which requires that monitoring results be posted on the web. Ontario maintains a drinking water system surveillance program. The quality of data in the Canadian drinking water data base is good, the issue is accessibility. The U.S. maintains a database (Safe Drinking Water Information System) of treated drinking water information, but data retrieval is problematic. Discussions between Ontario and the U.S. on data consistency and reporting would be beneficial.

Getting raw water quality data from water systems may be difficult. It's in different formats and parameters. Ontario requires records be kept 5 years. Most are in hard copy. The issue of archiving needs to be addressed.

What is the best way to assess raw water quality?

Are the "purpose", "ecosystem objective", and "measure", etc. OK as written in the indicator description?
Does the language in the ecosystem objective for the Drinking Water Quality indicator (#4175) accurately reflect source water protection concerns?

Most thought that the indicator should not measure water quality solely at the plant. The ultimate measure of the quality of the product provided to the consumer is at the tap. There was a consensus that water quality should be tracked at 3 locations: raw water quality at the intake, treated water quality at the plant as it enters the distribution system, and at the tap.

Some water contamination (e.g. radionuclides) is naturally occurring.

Taste and odor is generally considered a secondary contaminant. That means that standards exist, but they do not cause adverse health effects and are not enforceable. Telling the public that taste and odor is an "aesthetic" condition frustrates and angers the public. Taste and odor in their minds is a real problem.

Summary Statement:
Water processed through public drinking water systems should be of high quality, beginning with raw water,

then during and after treatment, and ultimately at the tap.

Supporting recommendations:
A uniform database is needed for storing drinking water quality data for these three focus areas, using available data. Avoid setting up parallel data collection systems.

Highlights of Index Discussion:

1. Indices may be useful if you define well, the question to be answered.
2. Need to be careful about the definition of index and the selection of indicators should recognize linkages.
3. Indices are an approach that can be a useful communication tool for decision makers and the public.

What do the participants think about an index approach?

- It is a good communication device. Vector mapping works well in different areas. It is another way to show progress.
- It is a simpler way of presenting data so that the public can have a scorecard of what the situation is at the moment.
- Indices should not replace indicators. Yet, it is an effective and visual communication card. A way to meet basic communication issues.

Clarify what is meant by an index.

- An index is a numerical value that relates to a complex situation and can be tracked over time. Examples include Dow Jones Index and the Air Quality Index in Ontario.
- Ohio River has a water index. It is a state index that is combined with data from Ohio and Kentucky. It looks at rainfall, combined sewer overflows, *E. coli*, weather forecasts, etc.
- The question of scale needs to be addressed. A whole basin approach?
- A *water index* (not just a *drinking water* index) was suggested.
- It is important that there be a trend.

What other indices are known to the group?

- The World Business Council for Sustainable Development has an index approach that looks at sustainable development.
- There has been some academic work on this subject from York University and Statistics Canada.
- Nortel has an environmental performance index.
- Used widely in industry as a means for quality control.

What are the limitations for Indices?

- Indices need to be defined as an aggregate process. The level represented by the index needs to be known. This is a question of scale. This can lead to a higher level of abstraction and/or synthesis.
- Indices show and hide something. Shows a number that shows the situation.
- There is the question of causality between indicators and indices. Some indicators are not specific to specific zones. Designed to be user friendly, not necessarily scientific.
- An index is a synthesis. They should not be constructed to create a trigger level. More for the consumption of the general public. Indexes are an early warning system.
- The indicators have already been chosen.

Is the goal a harmonized index across the Great Lakes? Perhaps there needs to be a separate index for each lake? Once again, this is a question of scale.

- Walleye, for example is a good indicator since it is a good integrator.
- Some people have a problem with it since it is negatively affected by cleaner water.
- Fish consumption is an example of an index that is too complicated. Different fish species and fish sizes have different consumption advisories. There is also the issue of synergistic effects.
- Use the Great Lakes Water Quality Agreement as the guideline for what is needed. Use indicators and indices to answer these questions.

What about drinking water? Should it be part of any index?
If you take a chemical approach, what would be included in a water index?

- The next step is not the selection of indicators for an index, but rather how they link together. There are synergistic influences and relevancies to each other that need to be considered.
- Need to be certain that indices provide value.
- There is a problem with getting something to a higher level of analysis. The question is not clear.
- Need to consider other approaches such as the benchmark approach employed in Oregon.

Index Discussion Summary:

- Indices are premature and need to first be fleshed out in a different form.
- Needs to be better defined.
- Need to be careful about what exactly is being communicated.
- Need to ensure that indices add value.

Human Health - Fish Consumption Advisories

Facilitator: Adele Freeman, Toronto and Region Conservation Authority
Recorder: James Schardt, U.S. Environmental Protection Agency
Number of Participants: 26

Highlights of Indicator Discussion:

1. An education component is an important aspect of communicating the significance of the advisory - people must be made aware of the risk of not heeding the fish consumption advisories.

2. The indicator developed (with concentrations and interpretation based on most sensitive population) is a good approach to a basin-wide indicator.

3. There is still a question about how this overall indicator relates to actual fish consumption advisories in the basin. A SOLEC indicator needs to address how jurisdictions interpret the data - maybe in another indicator.

4. There are data / models out there for incorporation and use in this indicator.

5. There needs to be a greater consideration of how this indicator will address the different fish consumption advisories which exist, in order for this indicator to be interpreted by the public.

Part 1: SOLEC Indicator #4083 - Contaminants in Edible Fish Tissue

Discussion of Fish Consumption Advisories Indicator

- Indicator presents a "Space Shuttle" overview of fish consumption advisories; it is unclear how it relates to more local, "biplane" scale.
- It is unclear how the target thresholds relate to locally implemented fish consumption advisories.
- This indicator is part of a suite of indicators that would indicate progress on clean-up. Overall program effectiveness would need to be confirmed with other indicators.
- This is a human health indicator (samples are skin on fillets). An ecosystem health indicator should also be developed (whole fish).
- The indicator uses a target level based on most sensitive populations. However, it is not clear how the exposure was determined. There is a need to standardize the exposure component.
- Figures should clarify that the data is from skin on fillet.
- It is not clear how fish contaminant loads translate into "can you eat the fish?".
- The endpoint of the indicator was questioned. Will this be comprised of the advice published in existing advisory booklets?
- The indicator may not address the most sensitive populations: special populations with enhanced chemical sensitivity.

Discussion of how to expand data set and share the indicator:

- The data set should be made available on the U.S. Environmental Protection Agency internet site.
- A list of federal, state, and tribal contact people for fish consumption advisories should be provided.
- Laboratories should be surveyed to see if there is more data available.
- Indicator should reflect the fish that is being consumed the most, probably not lake trout/coho.
- Indicator should report on mercury concentrations as well.
- Need to clarify terms, there is confusion with the difference between a contaminant level indicator and a fish consumption advisory indicator.
- The objectives of the indicator should be stated. Is the indicator only reporting on contaminant level trends or is it making a statement on human health?
- The relationship between toxic substances and consumption should be made clear in the presentation of the indicator. What are the ill effects from the toxic substances? For example, what does mercury do in humans? How does this vary between individuals?

Discussion of Overall Approach:

- Indicator should report on contaminant levels in fish and assess against a common benchmark.
- It was noted that there is a lack of consistency across jurisdictions.
- Indicator should indicate when/how often fish are fit for consumption.

Part 2: Pilot Study to Test Indicator on Lake Superior

1. Issues

- The existence of a different fish consumption advisory for each of the jurisdictions "screams" of inefficiency.
- There is a need to make fish consumption advisory information more understandable.

2. Existing data sets:

- Great Lakes Indian Fish and Wildlife Commission has one year of data on four fish species (using composite samples) from the south shore of Lake Superior, for organic compounds and mercury.

- Ontario Ministry of the Environment has data on lake trout, whitefish, and suckers for 12-13 locations on Lake Superior.
- Department of Fisheries and Oceans Canada has 20 years of data for whole fish (including lake trout and smelt) at four sites. Data includes organic compounds, PCBs, mercury, and other metals.
- U.S. Environmental Protection Agency Great Lakes National Program Office (GLNPO) data set.
- CORA has 10 years of data (Lake Superior is monitored every third year). Includes lake trout and whitefish. Has data on fillets (skin-on, skin-off).
- Also should have data from U.S. state, Tribe and academic sources.

3. Fish "Edibility" Indicator

- Two Components: Trends in contaminant levels, and evaluation of the contaminant levels to make a judgement about edibility.

Defining the Pilot Objective:

- This is an indicator. This is not fish consumption advice.
- Possibly could have different health benchmarks.
- What form do we want the data? Length, weight, etc.
- Database protocol needed.
    1. sample type (i.e. fillet skin-on, skin-off)
    2. quantification method for toxaphene
- Need an open forum to bring public into process.
- Relationships needed with other Great Lakes data coordination.
- Peer Review? QA? / QC?
- Need someone to store / assemble data, e.g.: a university or GLIFWC.

Discussion of the Index Approach:

Generally, the reaction to index development was mixed. The following are participants comments about the index approach:

- Good idea, but concern over the incomplete status of most indicators in their present state.
- Bad idea, the weighting of indicators to develop an index becomes a "black box." It is too easy to create an index that states the message you want it to.
- There is a loss of sensitivity with an index. It may obscure our ability to detect changes in the environment.
- Professional judgment is needed in interpretation of the data.
- The Netherlands have developed indexes, including product life cycle indexes. These could be a model.
- Suggest reporting on 10 key indicators with a separate score for each one.
- Indices simplify the data too much.
- Can we use existing indicators; do we need to re-invent them?
- It is questionable if this is the use of "sound" science, but it is timely to translate the science into something more understandable.
- It might be a good way to give the public a simple message – it paints a picture.

Summary of Fish Consumption Advisory Sessions

1. Regarding the draft indicator:

- It is good harmonize the exposure methodology and use a sensitive population for the benchmark.

2. Regarding the development of the pilot study:

- There is some interest in a pilot study for Lake Superior.
- Although there is some question on what is the value of doing things differently. We need a better definition of what we are trying to do.

3. Regarding important parameters needed to expand data set:
   1. Age / length & weight
   2. Sex
   3. Lipids
   4. Fillet vs. sample technique dorsal – conversion
   5. Season
   6. Location – Precise

4. Regarding the development of an index:

- The general consensus is that it isn't the right time to develop an index. The indicators need to be better developed before looking at how to summarize them.

Societal

Facilitator: Suzanne Barrett, Waterfront Regeneration Trust
Recorder: Michael Russ, U.S. Environmental Protection Agency
Number of Participants: 40

These two sessions focussed on discussions of the effects of environment on society.

Effects of Environment on Society:

Causes: - resource degradation
- resource limitation
- increasing population

Effects: - influence on economic systems
- shift in distribution system
- number of disputes, especially for limited resources
- rising costs of resources
- opportunities / recreation / native awareness
- separation between the 'haves' and 'have nots'
- understand points of pollution
- permits indication of prosperity
- behavioural needs and responsibilities (e.g. recycling)
- perception of environmental quality
- growth of NGO's
- shifts in spending
- power imbalances
- public health - child health
- shifts in employment
- change in education
- urban - suburban population shift

- ethnic population - different requirements and values
- shift inland / coastal
- effects on arts community and their work
- regulatory responses, change in demands from government, down-loading, arguments about rights - responsibilities should be focus
- disconnection of people from natural world
- spirituality and religion

Suggested Indicators

1. Public access to water body
   - Quantity (kilometres of access).
   - Quality of the resource.
     - Beware riparian rights.
     - Beware degradation by the recreational users.

2. Eagles
   - Native ceremonies (increase due to increased number of eagles).
     - National bird.
     - Symbol of "happiness" and indicator of ecosystem health.

3. Human health and reproduction
   - Fertility, family size, population density, demographics all tied together (increased population puts pressure on environment, endocrine disrupting chemicals may affect fertility).
   - Obesity in children - an impact of environment on kids.

4. Drinking water
   - Use of tap/bottled water/personal treatment devices.
     - Why? Perception of environmental quality, trust in water.
   - True costs (consider both costs of treating water and costs of bottled water).

5. Economic health
   - Property values.
   - Sustainability of resource based economies.

General Discussion on the SOLEC Societal Indicators:

- The SOLEC Economic Prosperity indicator (#7043) needs to be more than a measure of unemployment.

- Measures for Partnerships (indicators #3509 & #3510) could include:
  - existence
  - capacity
  - results

- Considerations for Financial Resources Allocated to Great Lakes Programs indicator (#8140):
  - Resources from whom?
  - What defines a Great Lakes program? (not just related to social issues)
  - Spent on what? Categories? Trends in spending for representative and total program. Are we robbing Peter to pay Paul?

  - Spending by agency.
  - Money spent by industry.
  - How much money is required to meet objectives?
  - Spending on prevention vs. remediation; science vs education.

- Integration of Ecosystem Management Principles indicator (#3510).
  - media content analysis
  - curriculum
  - percentage of population that knows about ecosystem management principles.
- First need to define "ecosystem management principle" - see the 14 impaired beneficial uses.
  - Industry measure (e.g. ISO 14001 of environmental stewardship).
  - Municipal/and other planning policies.
  - Province and state resource allocation.

- Sustainable Landscape Partnerships indicator (#3510)
  - define "landscape" - inclusiveness.
  - partnerships are important.
  - capacity = organizational richness
    = representative of community
    = vision/mission/goals/objectives/policies/evaluation
- Number of partnerships in the basin
- Participation by industry: resources and results

Other Considerations:
- Revisit titles of the indicators when components are done.
- What's the vision of an ideal society? Swimmability, fishability, drinkability?
- Environmental Justice
- Social justice / equity

Next Steps for SOLEC 2002 - Recommendations to the SOLEC Steering Committee
- Form work group to:
  (i) decide on societal indicators; and
  (ii) allocate leadership for reporting.
- Involve broad based group (including social scientists and economists).
- Facilitated by a neutral party.
- Start by reviewing/surveying global literature.
- Re-name the indicators later.
- Participants to use website to provide/continue input.

Ecological Indices

Facilitator: Anne Kerr, Environment Canada
Recorder: Glenn Warren, U.S. Environmental Protection Agency
Number of Participants: 45

Highlights of Session:

1. The majority of the participants were in favour of the indices presented in this session by Don Mackay and Paul Bertram.
2. There is still a question of which audience and what uses the indices that are most useful for.
3. We should look to other disciplines (epidemiology, graphic design experts) to help with presentation and reporting of the indices.
4. We should try some of these indices, get the information out to the public and gauge their reaction.
5. Diagrams were much preferred to a single number to represent an index.
6. The dialogue on the notions of indices, audience and use, must continue.
7. We don't want to lose the information (and monitoring programs) behind the indices.

Dr. Donald Mackay presented the ELP, or equilibrium lipid partitioning index. The ELP attempts to take all concentration data for a chemical, measured in different media, and put them into comparable units based on lipid partitioning. With the ELP, one could then combine and consolidate toxic concentration data for each chemical and each lake from all monitored media.

The ELP-converted contaminant concentrations from all media would not be equal, but would be comparable. What could we learn? As examples, if the fish ELP were higher than the water ELP, then biomagnification would be occurring: if the air ELP is less than the water ELP, then the water is most likely losing contaminant to the air.

A conclusion is that we must do a better job of reporting contamination levels to the public, as many believe that contamination is getting worse.

The discussion, which followed, had several main topics. The first of these was, "who is the intended audience?" The intended audience is environmental agency managers and the public. It was believed that the public could digest the index. The use, or usefulness of the index is the reporting of a single number that could be used to develop a target to be aimed for. Another question was whether to focus on one medium. The consensus was that the more information (media) used for the index, the more robust it would be. A supporting comment was that each individual data set was somewhat "flaky," while this problem was suppressed when many data sets were combined.

Dr. Paul Bertram presented a fishability index in graphical form. He stated that the intended audience for individual indicators is environmental managers or those who have a management role, while that for indices is upper level administrators and the public. The fishability index was a quadrilateral with an axis each for habitat, walleye populations, walleye tissue PCB concentration and preyfish. The vertices of the figure represented the desired state, and another figure inscribed within the quadrilateral represented present conditions. This makes it possible to see how far along the scale of management objectives we are.

In the discussion that followed, a concern was raised that we would end up with "a hundred of the polygons," which would be an overwhelming amount of information (ie. for different fish species, different contaminants and different lakes).

The majority of the group were in favor of pursuing an index such as that presented by Dr. Bertram, but the question again arose of which audience to aim for. The group also favored development of Dr. Mackay's ELF. A discussion of a graphical presentation of the index versus a single number resulted in support of the graph.

Other suggestions from the discussion included:

- We should look to other disciplines to help with data reporting and presentation.
- We should try some of the indices and get the information out to test reactions to the information.
- We don't want to lose the monitoring programs which provide information used for the indices.
- The dialogue on this notion of indices, audiences and uses must continue.

5.2 The Indicator Toolbox - Local Initiatives

Hamilton Harbour Area of Concern: Commitment, the Key to Success

Facilitator: Mark Sproule-Jones, McMaster University
Recorder: Wendy Leger, Environment Canada
Number of Participants: 39

Highlights of Session:

1. Water quality in Hamilton Harbour responds quickly to sewage changes. In the past improvements have been seen as a result of process improvements to the Hamilton Waste Water Treatment Plant (WWTP, improvements made 20 years ago). Hamilton Harbour is currently seeing improvements as a result of process optimization at the Burlington WWTP. However, Remedial Action Plan (RAP) targets for water quality are not being met yet and further improvements are required.

2. The Region of Hamilton/Wentworth (soon to be the new City of Hamilton) has set priorities to optimize WWTPs, to address deteriorating infrastructure and to reduce CSOs (combined sewage overflows). Worked with partners (including RAP, BARC, BAIT and others) to achieve the goals. Water and treated wastewater is not cheap. Must look at water pricing as a way of funding.

3. Through the Marsh Restoration Project, Cootes Paradise is improving. This program includes replanting, building of carp barriers, and water monitoring programs. Over the past 3 years there has been a decline in carp population, an increase in aquatic plant density and improved plant species richness.

This session was structured with three presentations followed by a question period.

Presentation 1: Water Quality in Hamilton Harbour, Murray Charlton, Research Scientist at Environment Canada's National Water Research Institute

- water quality will respond quickly to sewage changes.
- we have seen water quality improvements caused by process improvements made 20 years ago to the WWTP.
- we are currently seeing water quality improvements due to process optimization at the Burlington WWTP.
- therefore, we should be able to get further improvement at Hamilton.
- RAP targets are not yet being met.

Presentation 2: Treatment of Water and Associated Costs, Leo Gohier, Director of Water and Wastewater, Region of Hamilton

The Region of Hamilton has a 15 year plan which includes the building of CSO storage facilities (currently 5 have been built, 8 remaining).

Three regional priorities have been set - these include:

- optimize the WWTPs;
- address deteriorating infrastructure; and
- reduce CSOs.

Water and wastewater are not cheap. In Hamilton/Wentworth there are 3100 km of pipes (at a cost of $5 billion). Also looking at modular expansion of plants (costs money). Where do you find money to maintain and improve the infrastructure if you don't raise taxes? Could increase the water bills.

Cost of water (comparison):
25 L of water = $0.01
25 L of bottled water = $15
25 L of milk = $22
25 L of pop = $25
25 L of beer = $85
25 L of wine = $500

Questions & Answers:
Q1: Is tap water as pure as bottled water?
A1: City water has to meet more standards. Bottled water does have to travel through pipes.

Q2: What is the federal role in funding?
A2: Virtually none. Work is based on funding from water bills only. Subsidy programs that are currently in place cause the consumer to take water for granted. Consumer doesn't know the true costs of water.

Q3: What tests are done on water intakes?
A3: Measure - do a suite of tests on raw water. Inspection of intakes (intake about 1 km out).

Q4: Is there a time lag between when the test is take and when it can be communicated?
A4: Some tests provide results within the same day, others take a day or two. Some take even longer (ie. testing for metals - the results take weeks or a month). The critical tests can be communicated within 48 hours. Reports are submitted to the provincial government monthly.

Q5: Do you test effluent for toxic substances?
A5: Yes, on a quarterly basis. Currently there are discussions taking place with the RAP and BARC (Bay Area Restoration Council) to test on a regular basis so they can analyze for trends and patterns.

Q6: Do you test for copper sulphate from drain cleaner (e.g. Draino).
A6: No. There is no limit on what you can test for, therefore it is important to prioritize.

Q7: Are there special agreements with large polluters?
A7: There are compliance agreements for large polluters. If the problem is treatable, then they must treat it. If the problem is not treatable then there is an agreed upon timeframe for them to reach compliance.

Q8: What effect have zebra mussels had on the infrastructure?
A8: Zebra mussels can do damage to intake pipes. Currently, chlorination is the preferred method of control, however chlorination of intakes may introduce TFMs. Would like to move away from chlorine.

Presentation 3: Fish & Wildlife Habitat Restoration Project in Cootes Paradise, Len Simser, Natural Lands Steward, Royal Botanical Gardens

- in 1800s Cootes paradise was a completely vegetated shallow water marsh
- in 1934 there was 85% coverage by emergent vegetation, this was reduced to 15% in 1985
- loss of diversity occurred with the loss of vegetation

- currently have a replanting program
  - staff and volunteers
  - have own nursery
  - plant approximately 60,000 plants annually
- Carp (a non-native fish species) is a major stress to the ecosystem (churn up sediment and affect turbidity, destroy aquatic plants, destroy habitat...)
  - carp barriers became operational in 1997 (small fish can go through, large fish like carp cannot)
  - in Grindstone Creek native large fish are sent into baskets to get past carp barrier, carp are excluded
  - carp population is declining
- due to the replanting program and the carp barriers the aquatic plant density is increasing and the plant species richness is improving
- in Grindstone Creek, a tributary to Cootes Paradise, they have also initiated recycled Christmas trees as flow retardants, and are seeing the growth of wild rice

In Summary:
- there has been a 90% reduction in carp populations
- suspended sediment levels have dropped by 110%
- water clarity has improved by 100%

For more information visit the website at www.rbg.ca/fwhrp/

Questions and Answers
Q1: Is one of your indicators bottom feeding fish?
A1: yes, we are collecting information on them.
The marsh is in an urban area and has other stressors such as high nutrient levels, turbidity, high water levels (since Lake Ontario has regulated water levels).

Q2: Fishways - how are they paid for and sustained?
A2: These are dependent on DFO (Department of Fisheries and Oceans), internships and staff for research.

Q3: Steel Plant - does Environment Canada monitor emissions?
A3: The steel company monitors discharge, this is done through MISA. Data is sent to MOE and published on the website.

Launching and Maintaining an Urban Ecosystem Initiative

Facilitator: John Perrecone, U.S. Environmental Protection Agency
Recorder: Shannon Daher, Environment Canada
Number of Participants: 20

Highlights of Session:

1. Find common values among different groups of people. Even if people may appear different, they may share common values (i.e. the "yuppie" and the "joe 6-pack" may both want to preserve land for the future).

2. You can reach some people with nature, but for a lot of people we need to try a different approach - lay out the other things that go with urbanization, i.e. sprawl, traffic congestion, flooding, lack of open

space and decrease in biodiversity.

Effective Tools for Launching and Maintaining an Urban Ecosystem Initiative:

- Need to talk to the small community group.
- Let people do their own thing - don't add a bureaucratic layer.
- See what appeals to different groups, i.e. recreation/aesthetics.
- Get the private sector involved.
- Education - i.e. geese/deer may be a nuisance and we need to communicate why.
- Expand with partners that may be locally available (i.e. U.S. Environmental Protection Agency and other federal staff in Chicago).
- Think "grand".

Session Summary:

- This session looked at human uses in urban area with a focus on the Chicago Wilderness.
- If you "let an area go" - it doesn't necessarily become nature.
- It takes political will to restore/preserve urban ecosystems.
- Need the money to do it. In the case of the Chicago Wilderness funding came from the US Forest Service, US Fish and Wildlife Service, The Nature Conservancy, and Congressional support.
- Good science is needed - significant ecosystems/communities.
- What role can "you" play towards biodiversity was asked.
- Outline of the documents.

Q1: How do you convince people/congress that biodiversity is important?
A1: Biodiversity group from Wisconsin communicates this well and have helped them. Also, many people want to preserve for the future - find common values among people.

Q2: "Connectivity and Trails" - How important was it?
A2: Not overly important, the actual science of conservation was the key.

Q3: How do you encourage citizens to keep biodiversity in their yards?"
A3: There is a program in Chicago. We have found it works best at community level/city council level.

Leveraging Resources for Environmental Results

Facilitator: Richard Mariner, U.S. Environmental Protection Agency
Recorder: Laura Lodisio, U.S. Environmental Protection Agency
Number of Participants: 15

Highlights of Session:

1. Must invest in the process, in order to get results (i.e. invest in marketing to develop partnerships).

2. Resources means more than just money. Resources include:
    - leadership
    - volunteers
    - technical expertise
    - partnerships

3. Objectives must be clearly understood by all in order to get buy in to leverage resources.

Effective tools for leveraging resources:

Use the Chicago Wilderness Initiative as a model to create a metropolitan-wide initiative operating through existing volunteer organizations, without creating a new bureaucracy.

Chicago Wilderness Case Study

Overview of Chicago Wilderness:

- Lead by The Nature Conservancy (TNC) - initiated coalition
- Able to pull in other organizations
- MOU (Memo of Understanding) between organizations
- Leveraged resources from:
  - TNC
  - U.S. Fish & Wildlife Service
  - U.S. Forest Service
  - County Forest Preserve
  - U.S. Environmental Protection Agency / Great Lakes National Program Office
  - Local governments
  - Local Planning Organizations
  - Field Museum
  - Brookfield Zoo
  - Others
- Coalition formed through "partnerships"
- Congressional support (assisted in obtaining federal monies - $700,000 per year from both US FWS and the US Forest Service, for a total of $1.4 million/year)
- $13 million in funds over 5 years - including matching funds
- Lead to local funds in addition to federal funds
- "Member" contributions total up to 37% (including in kind contributions and funds)

Categories of Membership:

- General membership
- Council membership - requires a commitment of staff, resources

Membership does not yet include private business/industry. Chicago Wilderness is hopeful that this will happen and when it does happen they will create a Industrial/Business Corporate Council. The benefits to Business/Industry include:

- Native landscape of Corporate campuses; and
- "Clean Corporate Citizen" status.

Chicago Wilderness does not have tax-exempt non-profit status. Funding goes to individual organizations, Chicago Wilderness provides grants each year.

What is the "marketing niche" of Chicago Wilderness?

- Must provide benefit to all.
- Must be broad and flexible.
- Utilizes high quality outreach tools such as:
  - Quarterly magazine
  - Biodiversity "Atlas"
  - Colour/Glossy Brochures

    - Museum displays
- Had to defend public image because of "mis-perception" of burns, etc... (lack of education).

What was it about Chicago Wilderness that made it work and made it cohesive?

- natural alignments
- strong leadership
- build off "small successes"
- built on historical preservation efforts

Must have a common focus (i.e. Everglades, Chesapeake Bay, etc...) that draws in a greater area (i.e. State of Florida) - ownership of project must go beyond the boundaries.

What does an organization get from being part of the Chicago Wilderness?

- Matching funds
- Networking
- Communication
- Partnerships

Chicago Wilderness realizes there is a limit to federal funding. Need to reach out to foundations and other funding sources.

Developing the process was key in that it allows the "coalition" to do more than what the individual organizations could have done.

It's all about relationship building, partnerships, etc...

Important to partner with influential "non-government" organizations. (ie. the Brookfield Zoo, Field Museum, ...)

Biodiversity "Recovery" Plan (recent), 4 committees formed:

    - Policy
    - Education
    - Science
    - Land Management

Grant Program:

- Illinois Conservation Foundation is fiduciary organization to manage funds and issue grants.
- Chicago Wilderness shouldn't be "cloned" in other areas, but certain aspects can be used as a "model".
    - There are "elements of success" that can be used elsewhere.

Collection and Analysis of Monitoring Data

Facilitator: Vicki Thomas, U.S. Environmental Protection Agency
Recorder: Duane Heaton, U.S. Environmental Protection Agency
Number of Participants: 34

Highlights of Session:

1. Issue of scale - is there an appropriate "best management plan" to support the implementation of SOLEC indicator?
2. Quality assurance and standard protocols are necessary for indicator implementation success.
3. Scale - must define appropriate scale for monitoring.
4. Which of the indicators are truly the most important for assessing the health of the Great Lakes (maybe not all 80).

Effective tools for the Collection and Analysis of Monitoring Data:

1. Define questions
2. Develop measures and methods
3. Identify assumptions
4. Perform analysis and interpretation

Volunteer Recruitment and Retention

Facilitator: Cathy Keenan, U.S. Department of Agriculture
Recorder: Sandra Hellman, U.S. Environmental Protection Agency
Number of Participants: 21

Highlights of Session:

1. Marketing strategy - need to identify why, who and how.
2. Recognition (and appreciation) of volunteers in and out of the Program.
3. Training of volunteers - meeting the needs of both the organization and the volunteer.

There are two Questions to apply to all components of a volunteer monitoring program:
1) How do you **build** a volunteer monitoring program and its various components?
2) What **ideas** will make the program work?

Focus questions on how to **build a recruitment** program:
a) What should a recruitment plan include?
b) What questions should be addressed when building a recruitment plan?
c) Is the location of the volunteering attractive to volunteers? If not, how can this issue be addressed?
d) First contact – pros and cons of written versus verbal communication with potential volunteers.
e) Cost benefit issues of advertising – where is advertising most effective (e.g. wide range advertising effort vs. targeted groups)

Participant comments on how to **build a recruitment** program:

- Identify whom you want to contact. Identify all groups and parties you want to contact. Need good communication strategy to cover whole community. Use groups to network and get the word out.

- Target the audience, if you do have a specific audience in mind. But also attach information about the program in general news programs. Need to be media savvy, with an understanding of media available (radio, TV, newspapers).
- Volunteers need to know the time commitment. Is it short term, long term, yearly?
- Put the task in perspective with larger global picture (identify how the task fits into a larger picture). Adding scale gives people a good feeling about being involved with the cause.
- Don't reinvent the wheel. Use volunteer groups that already exist. Contact other volunteer groups.

Focus questions to produce **ideas** to make the **recruitment** program work:

a) What can we offer volunteers?
b) Material versus social incentives.

Participant comments on **ideas** to make the **recruitment** program work:

- Before you communicate, you need to identify your goals and vision statements. Develop a clear message about the goals and skills required. If you don't have the skills, we will provide them.
- Sell to the community that it's a worthwhile program.
- "Give to get." Make sure people are aware of what they can get out of it. For example, Cub Scouts can do work towards a badge. Contact people already organized as a group – they may want things to do.
- Need to identify physical capabilities needed up front.
- Identify each individual's skills and strengths. Do an assessment of skills so you know what you have in your group.
- Know how many volunteers are needed and what resources are available.
- Recruit from an associated company.
- Utilize high school students who have mandatory volunteer requirements. Provide access to educational opportunities.

Focus questions to **build a training** program:

a) Are training sessions required or are written instructions sufficient?
b) How often should training sessions take place for return volunteers?

Participant comments on how to **build a training** program:

- Identify the skills you need and match recruitments to that. Use skills assessment and match.
- Need to train people because you need to standardize data collection so that the quality of data is assured. Many volunteers see the training session as a social reward. They get to meet the other volunteers and discuss results. Can market training as a form of education. Training can be rewarding or career building. If you have a long-term project, training in the first year is a good investment.
- Trainees can become trainers. Government staff train volunteers, these volunteers now run the workshops.

Focus questions to produce **ideas** to make the **training** program work:

a) How should training sessions be approached? (e.g. lecture type, hands on)
b) What sort of props or activities would help make the training session a success?

Participant comments on **ideas** to make the **training** program work:

- Make the training fun.
- Celebrity access for volunteers.

Focus questions to **build** a volunteer monitoring program that will **retain** participants:

a) How often should volunteers receive feedback (keeping in mind the variety of forms feedback can take)?

b) How do volunteers' expectations change over time as they continue with the program?

Participant comments on how to **build** a volunteer monitoring program that will **retain** participants:

- Follow up with what you're doing –show the volunteers the results. This is important for volunteer satisfaction.
- You need to assess volunteer satisfaction.
- Career building opportunities and job skills – know your volunteers. For example, are they right out of high school?
- Recognize your contributors or sponsors.
- Let them know expectations up front. People like a project with a beginning and an end.
- Offer additional opportunities.
- Keep them informed about how the project is progressing.
- Have people involved in decision and planning.
- With time, increase responsibilities for volunteers.
- Get feedback from volunteers.

Focus questions to produce **ideas** to help **retain** volunteers:

1) List ideas for recognizing volunteer efforts (formal, informal, material, non-material)

Participant comments on **ideas** to help **retain** volunteers:

- Always thank your volunteers. Give them recognition: a) verbal recognition; b) certificates; c) local newspapers; d) publish results achieved; e) give out reports (newsletters); f) radio; g) get sponsorship of meal or t-shirts or hats (don't date t-shirts or hats) – these all point to volunteer appreciation.
- Write a bio on an excellent volunteer and put it in the local paper. Go outside the program with acknowledgements.
- Family appeal - keep it family friendly.

Focus questions to **build** a method on how to **assess** volunteer satisfaction:

a) How often should feedback be invited?

b) How should suggestions be acknowledged?

c) Written versus verbal feedback from the volunteers (also, within organization individuals versus independent contractors conducting surveys.)

d) What sort of questions might one ask to assess volunteer satisfaction and to obtain unbiased opinions about the program?

e) What sort of questions might be useful with regards to the background of the volunteers (i.e. what sort of information might be useful in focusing future recruitment efforts)?

Participant comments on how to **build** a method on how to **assess** volunteer satisfaction:

- Point out volunteer contributions and how it fits into the bigger picture.
- Point out the value of what they're doing.
- Adopt and recognize good ideas.
- Send a letter from the director outlining what person did so that they can put it in their resume.

Determining Priority Conservation Places

Facilitator: Joanna Kidd, Lura Consulting
Recorder: Greg Jenish, Lura Consulting
Number of Participants: 20

Highlights of Session:

1. Good start, need to conserve Great Lakes communities. Worthy of continuing efforts (e.g. a workshop on this specifically).

2. Need to involve people. Need a vehicle to communicate with people, but also involve them.

3. Integrate information through many new tools (GIS and maps). LAMP maps + GIS + U.S. EPA watershed identification. Key: some of the tools we now have permit us to do integration; we may not have been able to do this before.

Effective Tools for Determining Priority Conservation Places:

- Use the internet as a means of exchanging information and involving people.

The Alvar Initiative - Presentation by Heather Potter

This is a prioritization effort by The Nature Conservancy (TNC) - scientific approach. It may look like a very deliberate linear process.

5 components:

1. Terrestrial species and community
2. Alvar and community
3. Declining & vulnerable birds
4. Aquatic systems
5. Amphibians and reptiles

Process:

1) Identify conservation targets.
2) Develop conservation goals.
3) Assess viability.
4) Select sites.
5) Identify data gaps.

271 places (species, aquatic systems) identified - of these 60 (or about 1.5 million acres) have some combination of owners/strategies in place.

61% of these biodiversity areas are irreplaceable. 95% are not fully protected - only 5% are fully protected.

Questions to Heather:

Q1. How did you identify the starting points?

A: Through an eco-regional approach and using all the occurrences of species and site viability rankings. Go down the matrix, look at clusters (i.e. St. Clair River) then proceeded additively.

Q2. Concerned about the additive nature of the data; what about well studied areas vs less studied areas?

A: Data from natural heritage programs in the south are better than the north. For example, forest types are not well known and the Northern basin in the states is poorly identified.

Q33 Linkages and corridors in and out of basin? (i.e. going beyond isolated islands of info).

A: Larger connectivity valid (64 ecoregions being developed within U.S.), region-to-region stitching together.

Q4. Have you considered looking at sturgeon - they are a threatened and endangered species that are not just here now, but where here historically. What about rehabilitation and restoration for them?

A: We need to look at this (restoration strategies).

Q5. What about work on the Canadian side?

A: TNC has the funding and is getting underway. The Canadian portion will be completed in the next 1.5 years.

Q6. How do you choose priorities?

A: Need to protect the full range of biodiversity. Therefore, all areas are considered equal. TNC is dedicated to working in local communities first, then look at capacity and resources.

Questions asked to session participants:

1) How have other organizations identified conservation priorities?
2) How can we coordinate/integrate efforts to achieve greater and more efficient success in conserving priority places?

Response to Question #1 (identifying conservation priorities)

- Clients, environment, economics, community and laws all factor into objectives.
- How much participation from native/community groups? Spend a lot of time building trust and breaking down resistance.
- Cost-sharing incentives sometimes involved.
- It is important to address the future (i.e. future sturgeon spawning areas).
- Ducks Unlimited - next couple of months they are compiling activities and trends. Same process for wetlands. U.S. will be enabling next year.
- Great Lakes Commission - fish community objectives developed and will be on the agenda for the next couple of years. Meet fish community goals for trout, pike, etc. Environmental objectives will be developed next (species, habitats, etc.).
- Great Lakes Indian Fisheries and Wildlife Commission have been invited to participate in TNC's Alvar Initiative.
- Native peoples of Walpole Island recognize that: (1) all life is important, and (2) there are cultural and community values and considerations.

Response to Question #2 (coordination & integration of efforts)

- Lakewide Management Plans (LaMPs) - very valuable overlay map.
- Incorporate strategic objectives in Lakewide Plans (another resource). Lake Superior LaMP working with TNC - incorporate specific strategies/projects.
  - Identification of specific streams.
  - Local priority for conservation.
- Use map of TNC + Biodiversity Investment Areas + others maps to help make priority decisions.
  - Issue of scale, local community needs and wants.
  - Community staff on community level (work on project in their neighbourhood) what they can do where they like.
- We need to know how to communicate and we need to communicate with the wider community.
- Does TNC have a website? Post on the website?

[ecoregion scale]
[lake basin scale]
[local scale]

- TNC is open to thinking about how to meet the target. Get TNC paper on website. A lot more work needs to be done. TNC document is a living document.
- EPA perspective - went through by state on a watershed basis in order to determine priority watersheds for restoration). TNC, EPA and states trying to conserve resources.
- Overlay TNC map or EPA map on LaMPs map - would seem practical.
- Michigan: Clean Michigan initiative - funding for protection of high quality water.
- Federal legislation, Department of the Interior (the CARA Act) - could bring money to invest in state coastal areas, offshore oil drilling money.
- W.I.I.F.M. 'What's in it for me?'- Ensure that it is a win-win situation at the local involvement level.
- Draw on First Nations for communication/education.

Wild Rice Ecology and Management

Facilitator: Peter David, Great Lakes Indian Fishery and Wildlife Commission
Recorder: Ann McCammon Soltis, Great Lakes Indian Fishery and Wildlife Commission
Number of Participants: 23

Highlights of Session:

1. Rice is an important cultural resource with high nutritional value.

2. The value of traditional knowledge about harvesting rice was recognized by the State of Wisconsin in that they adopted regulations similar to the tribes for state harvesters.

3. There appears to be a broad interest from tribal and non-tribal people in restoring wild rice in other parts of the Great Lakes basin.

Session Summary:

Participants identified areas of particular interest including management, restoration and harvesting, wild rice's nutritional value, research needs, rice's historic range (particularly in the eastern Great Lakes), and rice as a potential indicator.

Jim St. Arnold gave a short presentation about the cultural and spiritual value of manoomin (wild rice). Wild rice is a sacred food that is used at all feasts, and historically tribal communities were established near wild rice lakes. Tribes have demonstrated that the traditional management of rice is most appropriate for the resource. As a result, in Wisconsin, wild rice harvest regulations for both Indians and non-Indians are based upon traditional tribal management techniques and opening dates for harvest on regulated lakes are determined jointly by the state and the tribes.

Peter David, GLIFWC Wildlife Biologist, gave an ecological overview of wild rice, discussed abundance and harvest monitoring, restoration and management techniques, and research. He suggested that wild rice could be an indicator of naturally functioning ecosystems. Rice demands that natural ecological processes be intact, especially hydrological processes.

The greatest interest among many of those participating in the workshop was to learn more about successful rice restoration techniques, and much of the subsequent discussion centered on people's goals and experiences in this arena. It is clear that the interest in restoration covers a wide geographic portion of the

Great Lakes basin, and that there is a need to assemble and disseminate information on effective restoration approaches.

The potential of wild rice as an indicator was discussed briefly among the larger group, mostly in terms of data availability issues. Rice distribution has been mapped in northwest Ontario. Harvest is also tracked more closely in Canada because of the different regulatory scheme in place there. Harvest and abundance monitoring is done in Wisconsin. Formal monitoring in other states is less extensive. However, the high interest in this resource has many individuals interested in expanding and coordinating monitoring efforts across rice range. In addition, since a fair amount of rice monitoring is already taking place, and since monitoring is not particularly expensive, it should be feasible to establish broader, coordinated monitor programs without great expense.

***Note:** Great Lakes Indian Fishery and Wildlife Commission (GLIFWC) has guidelines for wild rice re-seeding - interested individuals can contact GLIFWC for details.*

Shoreline Biodiversity Investment Areas (BIAs)

Facilitator: Adele Freeman, Toronto and Region Conservation Authority
Recorder: Melissa Hulting, U.S. Environmental Protection Agency
Number of Participants: 35

Highlights of Session:

1. In general, there was enthusiastic support for the BIA approach. However, there were some concerns about the methodology and rankings. Those with comments about the methodology and rankings should submit them as soon as possible to Nancy Stadler-salt (nancy.stadler-salt@ec.gc.ca) or to Paul Bertram (bertram.paul@epa.gov).

2. A companion piece to the BIA integration paper should be issued. This companion paper would include information on current conservation activities, land use, current protective designations, and threats to ecosystems, and other information if available. Much of this information is in the 1998 Nearshore Terrestrial BIA report.

3. An outreach and implementation plan must be developed to move this concept forward. A formal binational designation should be considered for the BIAs (similar to RAPs/AOCs). EPA and EC should perform outreach to local communities and designate a "local champion" in each area who will be responsible for mobilizing action. This champion could be an agency, individual, or NGO, as appropriate (support may be required).

4. Periodic status reports should be issued on the progress in BIAs.

Overview of the BIA Integration Paper (presentation by Ron Reid):

The starting point for the analysis was a set of 70 shoreline units. These units were developed using the coastal eco-reaches from the 1998 Coastal Wetlands BIA paper, which were subdivided using 1998 Nearshore Terrestrial BIA boundaries and nearshore aquatic zone information from The Nature

Conservancy work by Higgins.

Nearshore terrestrial areas are those generally within one kilometre of the lake. Nearshore coastal waters are those that extend offshore to the point where the thermocline intersects with the bottom of the lake.

Three criteria for the integrated BIAs are Species or Communities of Special Interest; Diversity of Habitats, Communities, and Species; and Productivity and Integrity. Multiple factors and datasets were used to determine values for each criterion. There were other datasets that could have been used, but may not have been included due to limited availability (e.g., data for only one country) or coverage. Finding applicable databases for the entire basin was problematic.

Charts within the report show how the data were compiled and ranked. The rankings were used to create maps for each criterion.

Comments are welcomed regarding the rankings or the process by which they were determined. Submit all comments to Nancy Stadler-Salt (nancy.stadler-salt@ec.gc.ca) or Paul Bertram (bertram.paul@epa.gov).

Rankings for Criterion 1 (Species or Communities of Special Interest) were determined using data on rare species and communities, identified high-quality habitat areas, the number and extent of coastal wetlands, and important bird areas. Criterion 2 (Diversity) rankings were determined using the shoreline diversity index, the shoreline complexity rating, and the fish use index (which used Atlas of Great Lakes Fishes data). The hardened shoreline index, trophic degradation rating, and historic wetland loss rating were the basis for rankings of Criterion 3 (Productivity and Integrity).

Ratings for all 3 criteria were overlaid, and the results are shown in chart form and as a map. The shadings on the map indicate the integrated ranking—darker shading indicates a higher ranking.

Readers are encouraged to look at the case studies at the end of the BIA Integration Paper. They examine very different areas. For example, Long Point has been studied quite a bit and has formal designations as a protected area, whereas the Les Cheneaux coastal wetland area hasn't been studied as intensively. All three case studies demonstrate the strong link between watersheds, tributaries, and lake water quality. They also illustrate the value of these relatively pristine areas as benchmarks.

Land use was not specifically examined as part of the ratings. Some information on land use was considered in the 1998 Nearshore Terrestrial BIA paper. The authors would like to use land use data in future refinements of the integrated BIAs. Some of the integrated BIAs identified in the paper are pristine, and some are degraded.

Since the identification of AOC's, there has been a focus on very degraded areas; we need to pay the same level of attention to fairly pristine areas through the BIA concept. One purpose of the BIA concept is to encourage public participation in conservation in those areas (and in others). What should the next outreach step be - a website?

The higher ranking of Western Lake Erie may come as a surprise since there are several cities there, however, it is due to the wetlands that exist in that area - there are a series of marshes in close proximity to each other, fish spawning areas, etc., leading to a number of overlapping high criteria values.

The BIAs should not be perceived as the ONLY important areas in the Great Lakes basin. It should be noted that this paper only looked at nearshore areas. It is also important to note that some of the higher-ranked shoreline units already have conservation activity going on, and some don't.

The BIA designation should not be used "incorrectly" to discriminate against action in more degraded areas. It may be possible and desirable to restore lower-ranked areas.

Next Steps

It is hoped that this paper creates conservation dialogue where it doesn't yet exist and encourages dialogue that is already going on.

It was suggested that a companion piece to the integration paper be developed. This document would describe the status of the areas in terms of intactness/land use pressures, current conservation activities and capacities, protective designations currently existing, etc. Some of this information is contained in the 1998 Nearshore Terrestrial BIA paper. The information gathering for the 1998 paper should be done for each high-ranking shoreline unit (BIA); this would make up the majority of the companion piece. We need to look at activities and status in the entire landscape surrounding the identified areas.

The BIA concept could be used to guide other processes; making sure environmental factors are sufficiently considered in EIS efforts, for example. It could also help areas get additional protective designations in the future.

Comments from Participants:

- One member of the discussion group noted that the OS7 unit (Eastern Lake Ontario) was not included in the upper tier of units. Many barrier beaches exist along that stretch, and he thought that it was important.
- The authors were complimented on a their approach to BIAs; "In 1998, people were just throwing out ideas for locations. This is a much more systematic approach."
- A participant wondered who "owns" this report? Who will issue the report? Are there any additional commitments from individuals, agencies, and/or groups? Recommendations could be issued and the BIA concept endorsed by Environment Canada and U.S. EPA. Some sort of action plan is needed. (Response: The data provided in the BIA paper (and in the companion piece) would be there for organizations, particularly local groups, to take advantage of. Environmental Groups need this information to push for ecosystem protection; and it could be ammunition for local folks. Some of these people may not know about SOLEC. We need to go out into the BIAs and perform outreach where there isn't any activity going on.)
- The BIA designation could be made a formal part of an international/binational agreement to give it more status. Could it be made an annex of the Great Lakes Water Quality Agreement? A binational designation could bring attention and resources to these areas, similar to that mobilized by the RAPs. The BIA designation could be one more criteria used in making funding decisions.
- Perhaps the Great Lakes Coast Wetland Consortium that was just created could look into studying these BIAs?
- We would need to implement activities for the BIAs at different levels of the community and government. Funding would be needed from government and private companies.
- Natural hydrology would need to be restored in coastal areas.
- Progress toward protecting and restoring BIAs should be periodically reviewed (every 3 or 4 years?).
- How will we motivate local groups and leverage resources? We need to go into these areas and talk to local people. Designating a local leader for each BIA would be a good idea.
- The BIA document and identification of high quality areas can be used in the face of pressures for

development.

- Identification of BIA "Tier" can be added to funding applications to attract resources for protection and rehabilitation.

5.3 Lake Sessions

Water Quantity in the Great Lakes-St. Lawrence River Basin

Facilitator: Michael Keating, Sustainability Reporting Program
Recorder: Rimi Kalinauskas, Environment Canada
Number of Participants: 20

Panel Presentations:

John Kangas (International St. Lawrence River Board of Control and U.S. Army Corps of Engineers)

- Water levels in the Great Lakes have been measured since 1860.
- The Great Lakes/St. Lawrence River is a dynamic natural system with long term fluctuations over decades.
- Based on historical records, water levels in the Great Lakes fluctuate on a seasonal and annual basis as well as cycles extending over decades (30-35 years).
- Seasonal water level fluctuations result in higher summer water levels and lower winter levels.
- The recent extreme high and low water levels that have been experienced on the Great Lakes are within the historical range.
- Regulation of Lake Superior and Lake Ontario has changed the water regime, dropping the peaks by approximately 0.5 m and raising the water level by 0.5 m.

Frank Quinn (National Oceanic and Atmospheric Administration)

- The potential impact of climate change on Great Lakes water levels has been modeled. Predictions range from slightly higher levels (UK model) to dramatically reduced levels (up to 3 m decrease) (Canadian model).
- Consensus opinion is that effects could be felt earlier than previously predicted.
- Climate change will change the seasonal cycle (currently 30-33 year cycles).

Doug Wilcox (U.S. Geological Survey, Biological Resources Division)

- Based on sediment records, water levels in the Great Lakes have fluctuated on a long term cycle of approximately 160 years as well as a shorter 30-33 year cycle for the last 3000 years.
- Water level fluctuations are very important for wetlands biodiversity and productivity.
- Great Lakes shoreline ecosystems are dependent upon natural disturbance processes, such as water level fluctuations, if they are to function as dynamic systems.
- Occasional high and low lake levels near the extremes of the historical record are required on all lakes in order to maintain wetland ecosystems.
- Regulation of Lake Ontario has had a negative impact on wetlands.

Christiane Hudon (Environment Canada, Quebec Region)

- Climate change will have a major impact on the water levels of the St. Lawrence River.
- Water levels on the St. Lawrence River have been very low in recent years and the effects have been compounded due to human activity.
- Can't control climate but can foresee major impacts, for example: smaller flows (up to a 2 m change in levels), higher frequency of droughts and heavy rains, salt water intrusion further upstream, shorter duration of ice cover and longer growing season. This, in turn, may cause changes in concentrations and flow of nutrients and contaminants, changes in the types and areas of wetlands, changes in species and distribution of plants, increases in zebra mussels, increases in fish parasites, loss of recreation areas (due

to more aquatic plants and reefs).

Richard Gaudreau (St. Lawrence Economic Development Council)

- Lower water levels are having a negative impact on the shipping industry.
- Low water levels affect the amount of cargo that can be transported by ship and affect profit margins directly. For example, for an average container ship that sails from Montreal to Europe, a drop of one foot means that 260 fewer containers can be shipped per vessel. This translates to a loss of approximately $200,000 per trip per vessel.
- Extra costs are also being incurred for dredging. Increased fees are being charged by the ports and the St. Lawrence Seaway.
- Lower water levels are already affecting the shipping industry. If water levels continue to decline, the amount of traffic through the St. Lawrence Seaway will be further reduced.

Steve Thorp (Great Lakes Commission)

- 17 metropolitan areas account for 80% of the population in the basin.
- Industrial water use has declined in the basin. Changes in manufacturing processes have meant that it is less important for manufacturing to be on the waterfront.
- For commercial navigation, water levels are a critical factor that affect vessel draft and thus the "bottom line". A one inch drop in level could mean a load reduction of 100 tons.
- Water levels also affect recreation (docks, need for dredging, etc.)

Group Discussion:

- On the use of "water levels" as an indicator of the State of the Lakes: There were mixed reactions. Some felt that changing water levels are a natural phenomena and as such did not "fit" the SOLEC categories very well. There are conflicting interests, what are the "optimum levels"? Generally, extreme high levels and extreme low levels are seen to be bad, as long as the water levels are in the middle range they are seen to be OK. Durations are important. (Note that the current SOLEC Indicator #4861, Effect of Water Level Fluctuation, only applies to Lake Superior and Lake Ontario).
- What is the government position on further regulation of the Great Lakes? No more regulation, focus now is on improving existing regulation. Lake Ontario will be looked at first.
- Can we forecast water levels? No, not really, we need to understand climate first. We are going toward probability forecasts (much like weather forecasts). Analogy given was to treat current forecasts of water levels, much like the 5-day weather forecast.

In summary, humans have a limited ability to control water levels. From a management/ sustainable development perspective we should: move towards integrated management; be proactive rather than reactive through forecasting; make enlightened choices between conflicting user groups; identify environmental and other consequences of management decisions; and mitigate impacts through punctual interventions or global water resources management (Christiane Hudon, Environment Canada).

Lake Ontario

Facilitator:
Recorder:
Number of Participants:
Session Summary: *Not available at this time*

Lake Erie

Facilitator: John Perrecone, U.S. Environmental Protection Agency
Recorder: Melissa Hulting, U.S. Environmental Protection Agency
Number of Participants: 31

Two presentations were given during this session:
1. The Big Picture Project by Don Gordon of Carolinian Canada
2. The Ohio GAP Program by Donna Myers and Melissa Haltuch of U.S. Geological Survey, focusing largely on the aquatic mapping with mention of other projects in Lake Erie jurisdictions. A summary of the Ohio GAP presentation was handed out to workshop participants.

Questions posed to presenters:
1. How effective are these databases at identifying the link between upland habitats, current land use, and aquatic habitats, particularly in terms of habitat function?
2. Can these databases provide a basis for LaMP managers to prioritize restoration activities in the Lake Erie basin?
3. How effective can these databases be at predicting or understanding changes in ecosystem components based upon natural resource management decisions?
4. How can this data be presented to land managers (including managers representing agriculture, industry, and urban areas) so it can be used for practical decision-making?

The Big Picture Project - Don Gordon, Carolinian Canada
Carolinian Canada, a coalition of non-government organizations and conservation agencies in Southern Ontario, was formed in 1983. It has identified 38 unprotected areas (islands of green) in the Carolinian Zone of Ontario and has worked to secure those areas though purchase, zoning, etc.

Islands of green are fairly ineffective in conserving biodiversity; these islands need to be connected. This can be difficult since southern Ontario is fairly developed. Currently the region has about 15% natural cover. About 30% is needed in order to preserve the full suite of biodiversity. The goal of the Big Picture Project is to increase natural cover to 30% (retained/restored) in the Carolinian Zone through the connection of existing protected areas and an increase in interior/core area.

"Green areas" were mapped using several GIS data layers, including First Nation areas and provincial and national parks. A point system was applied based on forest cover, species richness and diversity, connectivity and linkages, barriers between woodlots, etc. Green areas of greater that 400 hectares in size were identified. Most were isolated from other green areas. Low cost possible linking areas were determined—waterways, railways, utility corridors, etc. Other restoration/linking opportunities may exist for areas near highways, cities, active quarries, major roads, and high-value agricultural land, however, these would be at a higher cost. A cost grid was developed, showing high and low cost corridor areas. An algorithm was run to determine lowest cost connections between existing green areas, when high cost barriers were "hit" then an alternative route would be examined. "Metacore" areas, which would round out edges to core areas (buffer cores outside of 200 m), were identified. "Metacorridor" areas, which would make corridors wider, were also determined. This produced a final grip of cores and corridors. Areas with good restoration potential—with good soil types, for example, were also shown on the final Big Picture map.

A more detailed description of the Big Picture Project and methodology can be found on Carolinian Canada's website. Link to http://www.carolinian.org/Big%20Picture.htm. Carolinian Canada is exploring potential partnerships to expand this analysis to cover much of the remaining area in Southern Ontario (parts of Lake Ontario, St. Lawrence River, and Lake Huron/Georgian Bay watersheds) and also to do outreach to local groups to encourage protection and restoration of natural areas.

Question #1 (linking habitats): Yes, the final map shows linkages between upland and aquatic habitats. Valuable terrestrial areas are often near water.

Question #2 (basis for prioritization): Yes, this project can help prioritize restoration areas.

Question #3: This work cannot predict changes in ecosystems - it was not designed as a modeling tool.

Question #4 (presentation of data): A complete communications strategy has been devised for the Big Picture Project. Land managers are targeted, including players involved in development projects. Carolinian Canada is seeking ways to incorporate some of this work into official plans and other land use planning initiatives in municipalities.

Ohio Gap Analysis Program (GAP) - Donna Meyers and Melissa Haltuch, U.S. Geological Survey
The national GAP program started about 10 years ago, mainly in the western part of the U.S. where much of the land is in public ownership. Since land in the eastern part of the country is much more developed, the application of the GAP program may be somewhat different than in the west. The goal of the program is to provide an objective method for identifying gaps in higher-biodiversity areas and prioritizing restoration/conservation areas.

This presentation focused on the aquatic GAP, given that the Big Picture Project has a terrestrial focus.

The aquatic GAP has been funded over the last 3 years. This project is using landcover mapping (1999 LANDSAT 7) data to model both terrestrial and aquatic species. The GAP focuses on common species, not necessarily endangered and threatened species.

The elements of the GAP concept are:

1. Identifying and classifying types of biological diversity (ecosystem, vegetation, and habitat types, etc.)
2. Examining existing and proposed systems of protected areas and land management units
3. Determining which elements of biodiversity are under represented in the existing system of conservation areas

The work done involves:

- Mapping existing natural/semi-natural land cover
- Developing a habitat affinity database for all species (to identify hotspot areas)
- Modeling terrestrial and aquatic species distribution

- Mapping land stewardship areas and potential areas of value
- Analyzing the gaps between conservation lands, biodiversity hotspots, and habitat types
- Publishing reports and data for use by land managers

The terrestrial GAP analysis will look at terrestrial vertebrate species in Ohio and vegetation classification at the alliance level (dominant and co-dominant species). Vegetation alliances were developed by the Nature Conservancy.

The aquatic GAP analysis will examine hotspots of fish, crayfish, freshwater mussels, and macroinvertebrates. Streams were classified into Valley Segment Types (VSTs) by the Nature Conservancy. The analysis showed that long stream reaches make up less than 1% of the total kilometres in the area of study. Wetlands will be classified and mapped. Riparian areas will also be mapped.

Goals and Timeline: In 2000-2001—map land cover, develop animal databases for terrestrial and aquatic analyses, classify VSTs, and map riparian areas. For 2001-2002—develop habitat affinity information (to go with species distribution), model animal distributions, and publish CD on VSTs with all data layers included. For 2002-2003—publish land cover map, terrestrial and aquatic species distributions map, and riparian area map.

Detail on Aquatic GAP:

Ecoregional Drainage Units (EDUs—like watersheds) in Ohio are the basic assessment unit. VSTs are classified based on EDUs, stream order, temperature, bedrock type, type and thickness of glacial drift, gradient, and sinuosity.

A preliminary analysis was done for the area around Cleveland. Ohio EPA performed fish sampling for the analysis. The data was divided into quartiles based on average species richness. The 4th quartile has the highest potential for restoration (high species richness but low number of species). Sites in the 4th quartile for species richness were examined to determine their VSTs. Many of these high richness areas were closer to Lake Erie. To determine areas with high restoration potential, areas with the same VST as the high richness areas were identified. Few of the high richness/high restoration potential areas were on public lands.

Conclusions from this preliminary analysis:
- 19 VSTs out of 968 have at least 25 species of fish
- Most of these 19 VSTs are in large streams near the lake
- Sites with low species richness, but with the same VST as high-richness sites, have restoration potential
- The high-richness VSTs have high conservation value

Other efforts in the Lake Erie basin, including those by the Nature Conservancy (Chicago Great Lakes office), Ontario Ministry of Natural Resources, Michigan Department of Natural Resources/University of MI, and SUNY, use VSTs. The Pennsylvania Fish Commission is using small watersheds instead of segments/VSTs.

For more information on the Ohio GAP Program contact:
Donna Myers, U.S. Geological Survey
614-430-7715
dnmyers@usgs.gov

or visit one of the following websites:
National GAP analysis homepage is at www.gap.uidaho.edu/gap/
Ohio GAP homepage is at www.oh.er.usgs.gov/~rhaefner/ohgap.html

Question #1 (linking habitats): Where rivers meet shorelands are the most important and what happens upland determines its health.

Question #3: The data could present some info. on "Do something" or "Do not do something" scenarios. These models are not dynamic and they are not models of ecosystems, so they would not be able to predict changes. They are management tools for making decisions in sensitive/high value areas (zoning designations, etc.).
GAP analysis could be used for species recovery plans.

Question #4: Land use and stewardship information (including Ohio Dept. of Natural Resources (DNR) and municipal lands, conservation easements) will be mapped.

General Discussion:

- Separate stream reaches separated by dams were assigned a different code.
- Low species richness areas may still be high quality areas. Theses areas may have had low richness to begin with (ie. inland areas as compared to near the lake).
- Non-native species were not included in the species richness analysis.
- Spend money on those things that are causing the problem - as opposed to large watershed plans.
- Organisms for coastal wetland GAP analyses include all nesting birds. The Nature Conservancy's vegetation classification system will be used, since it includes wetland types. Floristic survey data will be matched with remote sensing data, and it is hoped that remote sensing can be used for the remainder of the state that has not had intensive floristic survey work.
- Use these products to be proactive vs. reactive - this approach has worked in local Ontario Municipal Board hearings and in local environmental assessments with success. Use corridor data to be proactive and not reactive. Create the early "vision".
- Similar to forested habitats in Ontario, 30% is also a magic number in aquatic habitat landscapes (based on analysis).
- Land stewardship map - used for both aquatic and terrestrial habitats.
- GAP analysis only conducted on public conservation lands. However, many high-richness and rare species areas occur off of publicly owned lands. Work from Ontario shows that current public lands do not coincide with hot spots. How will we deal with lands not in public ownership? How are parks managed vs. preserves? A: When we have identified core areas, go to the fine resolution - help with municipal planning (local managers). The results of this project should be presented to local managers (since most decisions about land use are made at the municipal level). Designated lands should be recognized in planning documents. Incentives for conservation (ie. lower property taxes) could be used. For example, Carolinian Canada is working with Middlesex County to complete natural heritage mapping in order to include it in the next Official Plan. Also work on adding/improving buffers and corridors by examining Conservation Tax relief program eligibility.
- Where the lake and rivers meet, there is high biodiversity. We also need to protect upland areas that feed into those rivers.
- Ohio's Transportation Needs - Vision 2020 Plan. The results of the GAP analysis can be used proactively to aid this program (to help locate new roads). Ohio Transportation 2020 may have a huge impact on biodiversity.

- Proposal: Profile outfalls to Lake Erie with sources and loadings upland.
- Identifying smaller areas of high biodiversity is useful since smaller areas are more easily managed. However, the watershed approach is being pushed now for degraded watersheds. How do we balance protection of small areas vs. planning for the whole watershed?
- Ohio DNR data will be used to ground-truth the models to make sure identified areas truly do have high value or potential. The Ohio data is rich in terms of fish species distribution (4000 fish collection sites).
- Donna Myers noted the need for a decision support system for data manipulation.

Follow-up, especially concerning the four discussion questions and other available datasets that could be used in these efforts, should be directed to the presenters and coordinators: Donna Myers (USGS), Lauren Lambert (Ohio EPA, lauren.lambert@epa.state.oh.us), Madeline Austen (EC, madeline.austen@ec.gc.ca), and Don Gordon (Carolinian Canada, vanhemdo@execulink.com).

St. Clair Corridor

Facilitator: Rose Ellison, U.S. Environmental Protection Agency
Recorder: David Cowgill, U.S. Environmental Protection Agency
Number of Participants: 24

Session Goal: To identify corridor-wide ecosystem issues in the Huron-Erie corridor and corresponding actions that address them and support ongoing restoration efforts in the corridor and its watershed. There were four presentations in this session.

The first presentation, given by John Marsden of Environment Canada, focused on the recent "Four Agency Letter of Commitment". The "Compendium of Position Papers - A Four Agency Framework of Roles and Responsibilities for Implementation of the Detroit River, St. Clair River and St. Marys River Areas of Concern Shared Remedial Action Plans", Feb. 2, 2000 can be found at: http://www.on.ec.gc.ca/glimr/raps/connecting/detroit/detroit_compend12.pdf.

Matt Doss of the Great Lakes Commission gave a presentation on the identification of overarching ecosystem issues in the Huron-Erie corridor (using Beneficial Use Impairments). Attempts were made to identify overarching issues common to various portions of the corridor.

The third presentation was also given by Matt Doss but looked at the identification of ecosystem issues for Lake St. Clair in order to guide restoration and protection efforts. Participants were briefed on the conference held on November 30, 2000 and December 1, 2000, entitled, "Lake St. Clair: Its Current State and Future Prospects". The Conference Summary Report for this conference has been published by the Great Lakes Commission, and can be found at: http://www.great-lakes.net/lakes/stclair.html. This document provides substantial detail about use impairments in Lake St. Clair and includes a number of recommendations from the conference.

It was noted that a number of commitments have been made related to Lake St. Clair. These include the inclusion of Lake St. Clair in the Four Agency Agreement (between Environment Canada, the U.S. Environmental Protection Agency, Michigan Department of Environmental Quality, and Ontario Ministry of the Environment and Energy), a new authority for the U.S. Army Corps of Engineers to prepare a management plan for Lake St. Clair, the commitment by the U.S. Environmental Protection Agency to support a biennial conference on Lake St. Clair, the inclusion of Lake St. Clair in SOLEC conferences and reports, and the commitment of funds by the U.S. Environmental Protection Agency to support outreach for Lake St. Clair, grant support to the Wildlife Habitat Council from the U.S. Environmental Protection Agency to develop a biodiversity atlas for the Lake St. Clair corridor, and a new web page for Lake St. Clair on the Great Lakes Information Network.

Issues identified in the session included: habitat loss, beach closings, human health issues, air quality monitoring issues, impacts of non-native species, undesirable algae/eutrophication, lake level issues, lack of public access to the lake, excessive aquatic plant growth, a shortage of information to judge beneficial use impairments, sediment resuspension, changes to the fishery, urban sprawl, hardening of the shoreline, dredging, and the need to identify pollution sources.

Allen Melcer of the U.S. Environmental Protection Agency gave the final presentation which looked at identification of actions and associated mechanisms to address corridor-wide issues. Activities identified that might help the integration into a corridor-wide effort include: the Eastern Habitat Joint Venture of the North American Waterfowl Management Plan, the biodiversity atlas, the St. Clair Channel Keeper, the bluegill monitoring research being done by Oakland University and the U.S. Army Corps of Engineers, and the Southeast Michigan Green Ways effort.

Lake Huron- St. Marys River

Facilitator: Jim Bredin, Michigan Office of the Great Lakes
Recorder: Vicky Thomas, U.S. Environmental Protection Agency
Number of Participants: n/a

The Lake Huron session was introduced by Jim Bredin, Michigan Office of the Great Lakes, with James Schardt, U.S. Environmental Protection Agency-GLNPO, providing a description of the SOLEC Indicators process. Jim provided the breakout group with a draft list of proposed indicators for Lake Huron (see Appendix F). Jim indicated that the proposed list was being reviewed through the Lake Huron Initiative and that he was looking for any comments from the breakout group based on discussion brought to light during the SOLEC 2000.

The following comments regarding the proposed list of indicators were discussed during the breakout session:

1. Add whitefish as an indicator as it is consumed more. Focus on lake trout as a sentinel species. Look at contaminants in amphibians as well as in snapping turtles. Add contaminants in humans, i.e. women and children.

2. Look at shifts from seasonal residence to permanent residence. Look at communities with setback ordinances. Look at the density of septic systems/zoning. Consider recreational pressure. Look at extent of shoreline development.

3. Add herpetiles in wildlife communities. Sea lamprey is an important indicator for Lake Huron.

Additional issues for consideration in Lake Huron indicators:

- Where does the St. Mary's River fit in?
- Should bass be included as an indicator for Georgian Bay?
- Intensive agriculture is a big issue.

Jim encouraged all interested to provide specific comment on the draft list of indicators.

Draft list of proposed Lake Huron Indicators can be found in Appendix F.

Lake Michigan

Facilitator: M. Williams, Walpole Island Heritage Centre
Recorder: Laura Evans, U.S. Environmental Protection Agency
Number of Participants: n/a

Presentation on the Great Lake Commission's Lake Michigan Project - Ric Lawson:
1. Lake Michigan Tributary Monitoring Project (see http://www.glc.org/monitoring/lakemich/)
2. Lake Michigan Monitoring Coordination Council

This project is a joint initiative between U.S. Environmental Protection Agency, Lake Michigan Team (provided project leadership and primary funding support) and the Great Lakes Commission (GLC), a binational agency directed by the eight states and two provinces (GLC provided administration, research and reporting on the Tributary Project and secretarial support for the Monitoring Council).

The goal is to create a framework for future monitoring and inventory the ongoing collection of data. This is an effort to understand the extent and breadth of existing monitoring and determine the gaps. The inventory will include federal, state, and local monitoring programs in collaboration with 14 tributary groups, and an analysis of LaMP indicator monitoring.

The monitoring inventory process included an inventory survey, phone calls and data search. The final report was a database of monitoring projects from the 14 tributary groups, open lake monitoring and monitoring from 9 other categories (listed below). The report identified the extent and range of monitoring coverage as well as identifying the gaps and overlaps. Two types of gaps were found: the monitoring programs/data was out there but they just couldn't access them, or , the monitoring program/data just wasn't available. Also included in the final report were recommendations.

9 Analysis Categories:
1) 18 LaMP Pollutants
2) Nutrients and Bacteria
3) Meteorological and Flow
4) Sediments
5) Fish
6) Benthos
7) Air
8) Wildlife
9) Land Use

Summary of Key Findings:

- Gaps in Inventory: include geographic coverage of fish populations, aquatic nuisance species, benthos, terrestrial wildlife and habitat. Also gaps in academic research inventory.
- Gaps in Monitoring Coverage: include wetlands measures, habitat changes, atmospheric deposition and diversity measures. Also gaps in groundwater monitoring.
- Underutilized Resources: include volunteer and local agency monitoring
- Compatibility and Coordination: lack of data, method standardization and coordinated networks. There is a need for a single source linking the monitoring information.

The second phase of the Tributary Monitoring Project is an on-line database.

- This will be an internet-based GIS database of monitoring information.
- It will be searchable geographically or by type of monitoring.
- Entries will have links back to the monitoring organizations for better awareness and access to monitoring data.

Information to be held in database includes:

- Program name
- Organization
- Contact information
- Link to data site
- Monitoring purpose
- Location description
- Parameters collected
- General methodology
- QA/QC characteristics

Lake Michigan Monitoring Coordinating Council (LMMCC)

- Council is structured along watershed (not political) boundaries.
- Broad ecosystem approach, not only water quality monitoring.
- Membership includes federal, state, local, tribal, non-government organizations (NGO), industry and academic organizations.
- Focus on improving monitoring standards, coverage, coordination, dissemination and awareness.

LMMCC Activities:

- Developing guidance documents
- Establishing pilot network
- Advising on the monitoring inventory
- Designing IAGLR (International Association of Great Lakes Researchers) and regional conference sessions
- Creating education and outreach materials

General Discussion:

- Want to catalog long-term ongoing projects.
- Collect baseline information.
- Monitoring implies that it is ongoing; otherwise it is more like sampling.
- An inventory gap is terrestrial monitoring, especially on private forestry land.
- Potential contacts were discussed for terrestrial monitoring, crayfish population information, and fish stocking.
- For information on Land Conservation (pg 136 of the report), it was suggested to look to at the Natural Resources Conservation Service, U.S. Dept. of Agriculture website (**www.nrcs.usda.gov/prms**).
- Need to look at habitat monitoring for a 10-mile radius for pipeline. The pipeline will be in before we have any information on habitat. Do not have inventory of habitat.

Indicators discussion:

- Need to determine the indicators we want to use and whether monitoring is available.
- The LaMP needs to focus on what are appropriate indicators.
- Put SOLEC indicator numbers on LaMP indicators, so they are compatible.
- Indicators can be confusing. We should look at it as if we have training wheels on.
- A recommendation was made that one person cross-walk with Ric Lawson / GLC work and fill in what we know. It may need more than one table.
- The recommendation then, to improve the table and fill it in was made. Do not use all 80 indicators.
- A process or way to prioritize is necessary. Monitoring activities will help with indicators.
- On-shore and off-shore aquatic habitat important.

For more information:
1. The report on the Lake Michigan Tributary Monitoring Project can be found at: **www.glc.org/monitoring**
2. The Lake Michigan Monitoring Coordinating Council web-site is: wi.water.usgs.gov/lmmcc/
3. The Great Lakes Information Network website: **www.great-lakes.net**

Lake Superior

Facilitator: Jim Cantrill, Northern Michigan University, Marquette
Recorder: David Rockwell, U.S. Environmental Protection Agency
Number of Participants: n/a

Jim Cantrill, Darrell Piekarz (Environment Canada) and Ken Cullis (Ontario Ministry of Nantural Resources) each gave a brief presentation on the status of the Lake Superior LaMP. Then the floor was opened and the remainder of the session was a question and answer period between the participants and the panelists. More information on the Lake Superior LaMP can be found on-line at http://www.on.ec.gc.ca/glimr/lakes/superior/

Session Highlights:

1. We need to be able to provide information on impairments to the public, in a way that the public can understand. This could help to obtain more resources in order to meet and remediate the impairments.

2. We need more interagency coordination.

3. We need to more closely mesh (more linkages) monitoring programs.

General LaMP Presentations:

- All issues are being considered - this is a basin wide approach.
- Geographic data: Lake Superior is comprised of 1/3 Canadian water, 2/3 U.S. water, although the watershed (land mass) is mostly Canadian due to Lake Nipigon.
- Nine chemicals, discharge elimination by 2020 - well on way to achieving this.
- There are 24-members in public forum to advise the LaMP.
- A LaMP report will be published every two years. The last one was LaMP 2000.
- Discussed the Lake Superior "best bet" indicators. What is being monitored for? What should be

monitored for?

- Further along in developing indicators, (including the interpretation of indicator meaning) than any of the other LaMPs.
- A workshop on monitoring in the Lake Superior basin was held in Oct. 1999 and a proceedings report has been produced.

Questions and Answers:

Q1. Monitoring seems to be missing for various contaminants - why?

A1. Herring Gull contaminant program saves a lot of expense since easier to monitor at the top of the food web. Water monitoring is highly variable and expensive. Should be looking for new (emerging) chemicals.

Q2. Currently we are looking at 10% of contaminant loading from point sources and 90% from air sources - where should we be directing attention?

A2. It is very expensive to monitor local mills. They may be releasing. Watching chemicals decline and level off. Point sources are pretty well covered.

Q3. Where is it coming from?

A3. It may be due to atmospheric loadings. Combination of variables. Burn barrels. Sediments. Seems to be a lack of attention to sediment interchange.

Q4. Do we have an example of a chemical that falls into this characterization (percent).

A4. Dioxin.

General Discussion:

- The discussion then turned to the difficulties of multi-national controls over contaminants transported from a long distance. Seeking controls. Seeking to control the in-basin sources which then become part of the out-of-basin problems.
- Discussed how information is collected on hexachlorobenzene and reported.
- There was a complaint about fish advisory reports. The fish reports contain two year old data. Long term reporting for fish monitoring data is needed in Lake Superior according to one attendee. Old data or no data available in some areas where the attendee fished frequently.
- Lake Superior binational monitoring workshop's goal was to beef up monitoring.
- The Great Lakes: An Environmental Atlas and Resource Book, 3rd edition (1995), was praised as useful in providing information. It was suggested that each of the theme groups may want to funnel their information into reports like the Great Lakes Atlas. Also, the Great Lakes Atlas should be updated and released again.

Indicators Discussion:

- Talked about adopting SOLEC indicators for Superior, but Superior indicators are different. e.g. swimmability issue is not key in Lake Superior.
- Looked at the Lake Superior indicators short list of indicators - see http://www.on.ec.gc.ca/glimr/lakes/superior/ for more information. Asked who can help monitor these and report to the Lake Superior workgroup.

1. Developing Sustainability Indicators.
   - Under Quality of Human Life indicators - recreation and cultural opportunities. New program tracking camping trail permits. Canadian input discussed.

- Minnesota counties can contribute to Resource Consumption indicators - solid waste generation & recycling programs.
- Great Lakes Commission may have input for Quality of Human Life indicators - transportation and communication infrastructure.
- What are the demands for social services? Answer - Alcohol rehabilitation.
- Question: Are we going to be sensitive to First Nation sensibilities? i.e. home ownership not a big deal on the reservation.
- Human health needs to be an end point more so than other life forms.

2. Terrestrial Wildlife Indicators.

- Want to cover all wildlife forms. Number of deer to number of deer carrying capacity. Could look at auto body shop repairs for cars damaged by hitting deer.
- Critical to look at the big picture, for example the natural range shift of ungulates causes a huge change in total numbers. Sometimes herds are overlooked in the counts because they have moved outside the range of the watershed.

5.4 Cross-Cutting Great Lakes Issues

Presenting Environmental Trend Data

Facilitator: Michael Donahue, Great Lakes Commission
Recorder: Mitch Sauerhoff, Sauerhoff & Associates
Number of Participants: n/a

Speakers: Don MacKay (Trent University, Environmental Modeling Center), Joe DePinto (Limno-Tech Inc.), Gail Krantzberg (Ontario Ministry of Environment)

Panelists: Andy Buchsbaum (National Wildlife Federation), Kelly Burch (Pennsylvania Dept. of Environmental Protection), Jay Means (Head, Department of Chemistry, Western Michigan University)

Introduction (M. Donahue) - SOLEC is about improving ecosystem integrity and monitoring our progress through a coordinated matrix of measurements. Once data is collected, how do we analyze the information and draw conclusions?

Presentation (D. MacKay) - "Contaminant Trends in Great Lakes Ecosystems"

What are the general trends for contaminant levels in the Great Lakes ecosystem? Trend analysis includes both short-term and long-term evaluations. There are three strategies (minimal, qualitative, and quantitative) which can be applied for trends analysis. The minimal strategy makes use of a simple linear plot of the data, with respect to time, to see if trends are discernible. The qualitative strategy utilizes semi-log plots of the data to view declines as first order relationships with respect to time. This is a reasonable strategy since most contaminant decay rates are dependent on lake contaminant levels at time of observation and therefore exhibit first order decay relationships. But a truly quantitative strategy postulates a mechanism of action and utilizes mathematical models to track historic or current trends and is useful for predicting future contaminant levels. Once verified, a model allows regulators and others to predict outcomes of management actions and to test them for effectiveness and cost/benefit.

PCB levels in Lake Ontario lake trout are decreasing about 5-10% per year. PCB levels in the entire Great Lakes ecosystem are decreasing, slowly decontaminating with time. The challenge is to report these data so that the declines can be clearly shown. Most data is not reported so that these trends can be readily discerned. IADN is a notable exception. These reports regarding Atmospheric Deposition into the Great Lakes provide examples of excellent data analysis procedure application.

Over the years, many media have been sampled including air, fish, water, and gull eggs. There has been a lack of consistency in the use of data analysis techniques. With low and variable concentrations, in water for example, it is difficult to discern data trends. Due to variability, eight-to-ten years worth of data are needed to establish valid trends. Biotic changes and food levels will influence short-term trends. In addition to the lack of meaningful data interpretation, there has also been a lack of timely reporting of data.

In order to facilitate an understanding of trends analysis, an analogy can be developed by visualizing a water tank being simultaneously filled from the top and emptied from the bottom. The tank, initially empty, is gradually filled when input exceeds output. The water level continues to rise until input equals output due to the weight of water or pressure on the bottom of the tank; a condition referred to as steady state. In this analogy, the water level represents the increasing levels of contaminants into the environment. This was the condition 25-30 years ago. As the contaminant load decreases (the rate at which water is being added to the tank), the level of contaminants in the ecosystem will decrease (water level in the tank goes down), but in a time frame later than the inputs. Where contaminant inputs are reduced by a factor of 3 to 4 times, the concentration of contaminants will decrease rapidly. That is the picture we have seen with contaminants in the ecosystem. At this time, we now see a slow, and over time, steady decrease of contaminants in the ecosystem (as the water level in the tank decreases slowly).

As noted above, there are three strategies for reporting on contaminants in Great Lakes biota.

- Report levels and the times the measurements were taken (the minimal linear graph approach);
- Present data using a first order rate constant semi-log plot (the qualitative presentation); and
- Analyze data through a quantitative mechanistic assessment and/or develop equations describing a dynamic mass balance.

Strategy three is more complicated and expensive but is the preferred approach for complex problems involving long-term commitment of attention and resources. Input values for this technique include the following data: tank size/values; properties of water; and water input rate. The rate of change (water level) per hour is calculated. The analysis is validated by comparing the calculated values with actual levels in the tank. By analogy, the water in the tank represents levels of contaminants in the ecosystem. The future can be predicted by knowing the input rates.

In reality, the Great Lakes are really two tanks - the water and the sediment. There are various inputs (air, point sources, etc.) and the two tanks are connected. Water levels of contaminants increase first, then slowly, contaminant levels in sediment catch up. Water levels of contaminants decrease first, and slowly, contaminant levels in sediment catch up. Contaminant levels in water will increase or decrease rapidly, sediments far more slowly.

In analyzing the contaminants trends data from a mass balance point of view, there are some difficulties. The inputs are not known accurately. Contaminant levels in the ecosystem years ago are not known. The water properties (temperature for example) change seasonally. Using the tank analogy, there may be several interconnected tanks. Even with these problems, mass balance analysis of contaminants in the Great Lakes can be accomplished. Key sources can be identified. Observed trends can be explained. The mass balance analysis gives important predictive capability - in other words, how the system will behave in the future. Mass balance analysis also shows what data inputs (point source, atmospheric) are most important from a loading point of view. A testable hypothesis can be developed that gives value and purpose to the data and demonstrates understanding. To provide a practical illustration of the conceptual model, a mass balance diagram of 2,4,5-TCP was presented showing various system inputs.

Researchers now analyzing contaminant trends data generally employ minimal to qualitative strategies. Noted exceptions are the previously mentioned IADN reports and the EPA Lake Michigan Mass Balance Project. With the exception of the Lake Michigan Mass Balance project, there appears to be little or no enthusiasm for quantitative analysis approaches. Certainly, the minimal strategy should not be employed. The IJC 9th Biennial Report recognizes the importance of modeling contaminant trends data and government support for model development. The government of Canada has not responded appropriately to the IJC recognition. The stage of science needs to progress with respect to contaminant level trends analysis. The persistent toxic substance issues in the Great Lakes merit the quantitative approach. They are long-term, complex issues requiring long time horizons for solutions and investment of significant time and financial resources. The cost of a strong factual/information basis for decision making is dwarfed by the cost of the management action that must be taken. To ensure efficient use of these valuable resources, decisions making processes must be supported by the quantitative approach.

Presentation (J. DePinto) - "Understanding Exponential Decline of PBT's (Persistent, Bioaccumulative & Toxic substances) in Great Lakes Water, Sediments, and Biota"

The quantitative analysis of contaminant trends data will, of course, provide modeling information well beyond what is characterized in the water and tank analogy. Models consider and provide information regarding the following:

- The life-cycle of typical PBT's in Great Lakes;
- The loading phase;
- The declining or wash-out phase;
- Mass balance model outputs and a means of interpreting trends (through first-order kinetics);
- Mass balance concepts and model linearity; and
- Examples of trend interpretation (role of Lake characteristics and "apparent slowing in rate of decline").

Typical Great Lakes PBT's are hydrophobic, associated with particulate matter in the water, semi-volatile (have an atmospheric exchange component), very bioaccumulative, and human exposure is generally through fish consumption.

The typical life cycle of Great Lakes PBT's is characterized by high emissions and loading during the 1940's through the 1960's, significant decreases in loading during the 70's and 80's with corresponding, but on a differing time scale, decreasing levels in biota.

Without the influence of natural processes, loading of PBT's to Great Lakes increases contaminant levels in water rapidly, with a slower sediment response. The water column levels arrive quickly at steady state while sediments are still on the increase. Sediment levels will still be increasing, not having reached steady state, while loading decreases. When loading decreases, the water column responds quickly, the sediments respond far more slowly.

The typical pattern of sediment loading can be examined by looking at sediment cores. The history of loading is in the core. PCB sales in the U.S. correlate with core history. Questions can be formulated from examination of core histories.

PCB's in lake trout data (1970's through the present) were presented. Why did PCB levels in biota decline at an exponential rate and then apparently slow down? PCB in herring gull eggs data (five Lakes) was presented. How is this data to be interpreted?

Equations were shown describing a first-order rate process. Trends data can be plotted on either linear or semi-log coordinates. The decrease in concentration is a linear function of the concentration itself. If a log-linear plot of concentration versus time demonstrates a straight line, then the decrease can be confirmed to be a first-order process. What does a first-order process mean? It means that the rate of decline is dependent upon the level of the contaminant present at that particular time. The change in concentration versus time data reveals that a constant fraction decreased per unit of time. The same fractional decrease will occur in the same time period. This is often expressed as a half-life, or the amount of time required for the concentration to decrease by one half.

First-order regression analysis can be applied to concentrations of PCB's in Lake Ontario lake trout.

EPA data covers almost a thirty-year time span (1970's through 1998). Graphing the data demonstrates a half-life of 8.7 years (time for the concentration to decrease by one half). The annual rate of decrease is about 8% per year. Some would incorrectly interpret this to mean that loading is decreasing 8% per year. From this graphical analysis, a reconstruction of loading history through the 1980's is possible. The half-life during this time frame was 5.5 years, or about an annual decrease of 12%. The correct interpretation is that loading of PCB's was decreasing faster than the decrease in PCB concentration in lake trout.

How can we connect loading of PCB's to Lake Ontario with concentrations in lake trout? In fact, a mass balance concept model is required. The model allows development of a relationship between loading of PCB's and lake trout concentrations. Equations can be written that keep track of the transfer processes. First-order processes govern persistent bioaccumulative substances transport and transformation processes. Mass balance equations were shown that characterize the processes. Mass balance models are linear, lake loading limits the rate at which PCB's levels in fish decline.

A history of PCB loading can be reconstructed with mass balance models. The outcome or forecasts of different loading scenarios can be predicted.

Toxaphene washout data from Lake Michigan and Lake Ontario were presented. There were some differences in washout rates because of physical differences in the Lakes. These are temperature, lake geometry, hydrology, and solid dynamics. Lake Ontario responds more quickly. Models are needed to understand and explain these relationships. Use of a minimal data trend assessment approach will lead to wrong conclusions.

PCB concentration trends in Lake Walleye were presented. Changes in ecosystem structure affect the rates of decline. Why does the curve appear to go flat? The explanations are in the lake biology. Again, models are needed to understand and explain these dynamics.

In summary, PCB's in the Great Lakes ecosystem decrease at a first-order rate. The rates of decline and changes over time depend on the properties of the Lake. Mass balance models are needed to define these trends.

Presentation (G. Krantzberg) - "Policy Implications of Trend Data Analysis"

Governments have set policies around PBT's in the Great Lakes basin. Policies have been based on the Great Lakes Water Quality Agreement, legislation and regulations, and management objectives.

The Great Lakes Water Quality Agreement provides tools to guide management of PBT's in the basin. Article II includes a provision for no direct discharges. Annex I states that discharges will be virtually eliminated using best available technology. Technology advancements imply ongoing abatement efforts. Article IV indicates that achievement assessments are to be based on statistically valid sampling data focusing on Areas Of Concern and critical pollutants.

The Binational Toxics Strategy is working toward the virtual elimination of PBT's.

The UNEP POPs program focuses on decreases or elimination of PBT's. The issue is -- does this allow a risk/managed approach or employment of the precautionary principle.

In the legislation/regulation arena, Municipal Industry Strategy Abatement (MISA) requires no lethality at the end of the pipe and virtual elimination of PBT's.

Virtual elimination requires a real analysis of the data. The raw data itself, as made available through the minimal approach, is not useful for decision making. Policy development must be grounded in fact. Agencies should be open to techniques in data analysis.

Accuracy in data measurement and data analysis is important because it allows identification of sources of PBT input. It will allow for a prediction of the time need to reach zero PBT's in the Great Lakes basin. It will identify processes that require more quantification (i.e. mass balance efforts).

Two scenarios should be considered. If the time to virtual elimination cannot be predicted, then more investigation of sources is required. If concentrations of PBT's continue to decline, the continued drive for virtual elimination is based on the precautionary principle, and we cannot lessen abatement initiatives. However, while the time to zero may be based on science, abatement decisions must include socio-economic parameters. From the socio-economic standpoint, what is an acceptable virtual elimination time frame? Data is needed to make proper interpretations.

Panelist Reaction (A. Buchsbaum) - Looking at the presentations this afternoon, trend analysis depends on and is governed by the audience. The audience may be policy makers, scientists, and/or the public. From a policy perspective, the questions are basic. How bad is the contamination now? Is it improving or getting worse? How long will it take to eliminate the contaminants? How much will it cost to eliminate contaminants? The trends data do not show the goals or objectives of virtual elimination. Virtual elimination is a concept, not actually a numerical limit. But the goal of virtual elimination requires that we implement water quality standards that protect human health and wildlife. EPA has done that through the Great Lakes Initiative (GLI) standards. These numbers are so low as to be close to virtual elimination. For example, the GLI mercury limit is set at almost the pre-industrial level. Virtual elimination is driven by science. The key for policy makers is to understand where we are now and where we want to go. There is a need to see trend data at lower exposure levels. Models can answer basic scientific questions. Current Total Maximum Daily Load (TMDL) modeling efforts in the U.S. are significant for mercury. Other sources of loading must be understood. Loading may continue or may actually be increasing. It is unclear if we have reached steady state. It is imperative that caution is exercised and we take action now to reduce loading of PBT's to the Great Lakes and not wait for the modeling results.

Panelist Reaction (K. Burch) - From what we've heard today, it appears that 8-10 years worth of data are generally required to establish trends. Scientifically this may be valid, but this time frame is too long for the general public. The public wants a more immediate response to its questions and oftentimes trends analyses are too difficult for the layperson to understand. In order to make informed decisions, however, the public requires more than just the simple presentation of raw data. It's also been my experience that they seem to place a greater degree of trust in outside experts to perform the scientific analyses and put forth recommendations along with their conclusion. In addition to data analysis, the governments have an obligation to meet the publics' demand for monitoring to ensure restoration targets are achieved. Once again, turnaround time for presenting the data must be acceptable to the public. This suggests that the qualitative approach is the best strategy. The public has long been the driving force for setting policy at both the state and federal level. Having set the policy, we, as government agencies, evaluate the science necessary and issue regulations or guidelines to carry out the policy. There will always be scientists on both sides of the trends analysis issue to argue that levels of contaminants will continue to fall vs. a new plateau has been reached. In the end, politicians will continue to respond to public pressure and allow the government agencies to decide on the appropriate science.

Panelist Reaction (J. Means) - Which way will the trends analysis curve go from here? Will it flatten out or even increase? A great deal is at stake here: ecological health; human health; levels of concern about chemical contamination increasing; dollars; the public; industry; etc. Why are the trends analysis unclear? There are analytical concerns. Do we really know the inputs of PBT's to the Great Lakes? Do we fully understand the biological processes of the Great Lakes? Strategies must be integrated. Are we measuring the correct components of the mixtures? Measuring total PCB's vs. the most toxic congeners may be a better way to go. Do we understand the hydrodynamic processes, where is the water really going? There are critical biological endpoints, like endocrine disruption, that have not been modeled. Our goal is to eliminate harm. Should we be focused on toxicological endpoints rather than chemical concentrations?

Questions/Answers/Comments

1. **Q:** At the end of SOLEC 98, there were discussions about building a data catalog, did this happen? **A:** The catalog is being built, however, the date for completion is unclear.
2. **C:** At some point, decisions have to be made with the available data. Achieving virtual elimination may come at great costs.
3. **C:** Policy decisions must be based on available information. The virtual elimination policy goal looks at PBT's. There is a cost of the status quo. There are financial consequences for actions and inactions. Recreational fishing produces huge revenues for the basin.
4. **C:** Model output can always be compared to endpoints. At times, the desired endpoints are unclear. Even with no additional input of PCBs, it will take 30-40 years to achieve a 0.05 ppm level of PCB's in Lake Ontario fish. It will take longer for Lake Michigan. Models will help us identify the most cost-effective remedy. Without models all we can do is guess. It takes models to tell us what the outcomes from our actions will be.
5. **Q:** We have heard in this session that there are 3 basic analysis strategies for trends data. Can we agree that strategy 1 (minimal) is not useful? **A:** Andy Buchsbalm said, "It all depends on the audience. I can't think of an audience for which the minimal approach would not be useful, but there may well be one. I can't rule out using the minimal approach." The other panelists did not respond verbally. Although there was some nodding of heads from some panelists, suggesting agreement, consensus was not expressed on the question.
6. **C:** It is very expensive to collect data. Running a model analysis is, by comparison, cheap. The value added for quantitative analysis is enormous.
7. **Q:** An earlier speaker (Thursday morning session) stated that levels of PCB's in the Great Lakes are no longer decreasing. That earlier speaker was wrong? **A:** Viewed on a linear scale, small decreases are difficult to see. Levels continue to decrease in Lake Michigan.
8. **C:** Data collection and modeling, using the data, are necessary.
9. **C:** A balance needs to be achieved between spending money on modeling vs. spending money on pollution prevention.

Naturalized Knowledge Systems

Facilitator: Dave Dilks, Lura Consulting
Recorder: Mike Russ, U.S. Environmental Protection Agency
Number of Participants: 25

Presenters: Henry Lickers, Mohawk Council of Akwesasne
Rod Whitlow, Chiefs of Ontario
James St. Arnold, Great Lakes Indian Fish & Wildlife Commission
Dean Jacobs, Walpole Island Heritage Center

Naturalized Knowledge Systems (NKS) - Henry Lickers

In literature, there are 1000 names for traditional knowledge. Some other points to consider are:

- Only native people can hold traditional knowledge.
- It is not static.
- How do you map it?

Henry Lickers prefers the term Naturalized Knowledge Systems (NKS) rather than Traditional Ecological Knowledge (TEK) as it refers to the way in which people (all people) and their knowledge adapt, or become "naturalized", to the land upon which they live or depend.

NKS keeps knowledge and passes it on to others and other generations.

Basic NKS Principles
- Earth is our mother.
- Cooperation is the way to survive.
- Knowledge is powerful only if shared.
- Spiritual world is not distant from earth.
- Responsibility is the best practice.
- Everything is connected to everything.

H. Lickers 1994

All communities living close to the land share these principles.
Charge - How can NKS contribute to SOLEC?

Native/non-Native Relations:

The presentation highlighted the need for respect, equity, and empowerment in Native/non-Native relations. Aboriginal people will not be able to fulfil their responsibilities to the land, and thereby demonstrate and share their knowledge on how to do so, without sufficient respect for Aboriginal knowledge being afforded by non-Native society, and in particular by government agencies. This respect must be used to develop equity in Native/non-Native relations through empowering First Nations with the resources they need to work on an equal footing with non-Native organizations.

Balance of:

Respect	Equity	Empowerment
Understanding	Finances	Application
Communication	Knowledge	Authorship
Consensus	Networks	Credibility
Mediation	Personnel	Partnership
Honor	Social Power	Responsibility

A Case Study in the Use of NKS - Rod Whitlow

The EAGLE (Effects on Aboriginals from the Great Lakes Environment) project provides an example of a long term study that utilized both western science and TEK for understanding human health in the Great Lakes basin. The EAGLE Project started in 1990 and it was based on the First Nations early indicators: deformities in bald eagles and other species, and changes in taste and texture of fish and game tissues. The mission of the EAGLE project was to identify continuing effects and thereby provide First Nations with data and strategies for environmental health of future generations.

There are 63 First Nations in Ontario. 47 participated in the EAGLE project.

Conventional environmental studies with Aboriginals didn't fully involve, or report back to, the communities.

EAGLE had full partnership with communities, including long term involvement and confidentiality.

Research components include social cultural effects. This is not generally distributable to the public. Some are elements sacred to the local community.

Principles of EAGLE research protocol:

- Research ethics ensured community control.
- Researchers to adhere to protocols.
- Community and study participants must understand the research tools.
- Respect for the culture, language, values and knowledge is essential.
- Aboriginal and community peer review and consultation important.
- Post study resources and support included (unique).

Socio-Cultural Research

The goal of combining community-defined wellness indicators with standard social indicators. This is very difficult.

Land use - Being out on the land is central to well-being.

Lessons Learned from the EAGLE project:

- Mandatory post study support essential.
- Governments and First Nation leaders have a responsibility to the community for environmental justice.

Other Issues:

- First Nations should not have to justify their world view and expectations.
- How can western science and TKS inter-relate?

- It was felt that TKS should not be pressure state response. Burden should be on polluter.

Great Lakes Indian Fish and Wildlife Commission - James St. Arnold
Great Lakes Indian Fish & Wildlife Commission (GLIFWC) is an organization which resulted from federal court recognition of tribal hunting and fishing rights. A portion of the treaty areas are within the Great Lakes basin. Within GLIFWC, spiritual and medicine people have important roles to play, as do the Elders, in making resource management decisions. GLIFWC can not give answers on behalf of tribes, but must go back to Elders and communities.

- Elders seek to have spirituality (how they live from birth to death, 24 hours a day) brought in to discussions and plans.
- Education is important. The Tribal perspective is brought to Federal and State governments. Tribes seek to educate bureaucrats - but need not show them everything.
- Heavy metal analysis - included full knowledge of how Tribal fishermen fished, filleted, etc.
- Input to Resource Management Plans. Input to US Fish & Wildlife Service and others. Medicine people are protective of their plants. Respect of Aboriginal knowledge is required. Sometimes may say "Don't go there" even without need of saying why.
- Important to note that NKS is an ongoing process. One cannot expect to have a full explanation of NKS in a 15-20 minute presentation. There is no "instant" TEK.
- Look to the Spirit to tell you what needs to be said. In discussing Forest Management, led to say what was the most important thing - RESPECT.
- Spirituality tie-in is a key. SOLEC should identify/develop spirituality.
- SOLEC should continue the work with Aboriginal people, but should not expect Aboriginal people to do it all at once - need to start with concerns and indicators.

Walpole Island TEK Study - Dean Jacobs
Stewardship is central to governance and relationship with land and water. Understanding and respecting Aboriginal values is important (need to understand what they are and why they are important). TEK can contribute to protection and restoration in the Great Lakes basin.

The land view is all-encompassing and demands stewardship. Governance differs from domination and control. People, instead, are subject to the land's dominion. TEK relays information about the relationship between people, land and resources.

Value of TEK:
- Oral tradition can have value and basis.
- Plans, mitigation may need to reflect traditional use.

Questions bearing on traditional use (used in an environmental assessment for the siting of a pipeline):
- traditional fishing and hunting areas
- traditional collection/use of plants
- traditional travel routes
- traditional ceremonial or spiritual areas
- traditional burial sites or other sacred places
- traditional important past events
- traditional names of geographic sites and areas

This information was gathered by interviews (open ended questions), audio recordings and mapping (GIS).

Conclusions:
- Impacts noted. Feast held after study to thank participants. Results brought to community.
- It is possible to do study quickly (2 months) and well if adequately resourced.
- No instant TEK, but if traditional values are recognized, it is possible to work together.

General Discussion:
After the four presentations the floor was opened to the session participants. The following are questions from participants to SOLEC organizers:
- Can the next SOLEC start with prayer and pipe ceremony?
- Activity for SOLEC to examine itself - a process indicator.
- Can SOLEC be in a First Nation location?
- How involved are Tribes in RAPs and LaMPs? Mixed. Only governments allowed on writing team. In some cases Tribes are recognized as a government.
- First Nations may not be comfortable as an indicator.

In summary:
- SOLEC showed how it is hard even just to talk with each other
- Stakeholder. I see a whole bunch of people who want to work together for future generations. Spiritually, economically, environmentally, ...

Endocrine Disrupting Chemicals & Pharmaceuticals

Facilitator: Anne Kerr, Environment Canada
Recorder: Dan Hopkins, U.S. Environmental Protection Agency
Number of Participants: n/a

The session began with presentations from each of five distinguished panel members. Dr. Mark Servos (Environment Canada) began with a presentation on endocrine disrupting chemicals ("EDCs") in the environment, providing a background piece and context for the workgroup discussion.

Next, Dr. Michael Wade of Environment Canada's Health and Environmental Communication and Safety Branch described what EDCs are, the effects caused by EDCs, and some evidence of a potential relationships and trends between exposure to EDCs and observed effects in humans.

Dr. Cliff Rice discussed analytical results of testing for alkyl phenol ethoxylates ("APEs") in sediments and fish samples near waste water treatment plants. He described in detail a variety of chemical structures for several APE compounds and the importance of characterizing these structures through chemical analysis. Dr. Rice stressed that APEs are not the only EDCs found in waste water, but that they appear to be important ones.

Dr. Sheridan Kidd Haack - presented information about pharmaceutical chemicals and emerging issues related to stream waters in the United States. She presented information about antibiotics found in ambient U.S. stream waters. Her data represented 32 (thirty two) of 145 (one hundred forty five) samples. She cautioned that there may be some change pending the completion of the analyses.

Dr. John Geisy - Dr. Geisy expressed the view that wildlife can be sentinels for the effects of EDCs. He identified the term "signal transduction" effects in regard to the ability of EDCs to mimic natural hormones. He cautioned that we should think more broadly about using more than one endpoint because we aren't that sure about the mechanism causing a particular effect.

Shortly, he expected to have toxicity data for nonylphenol and nonylphenol ethoxylates.

He questioned whether resistence to drugs is occurring or not, adding that more assessment is needed. Related to effects on human beings, he said the environmental levels of some of the pharmaceutical chemicals is 1/1000 (one one-thousandth) to 1/200,000 (one two-hundred thousandths) the concentration necessary to have a therapeutic effect. However, whether these chemicals accumulate in wildlife and whether there is an associated adverse effect, we don't yet know.

He said that the next challenge will be to find more environmental information and conduct more screening tests.

The expert panel took questions & comments from the workshop participants.

Question: What is NP ("nonylphenol") used for?
Response: used as a surfactant in cleaning agents, as an adjuvant (a substance that non-specifically enhances the immune response to an antigen) in pesticides and spermatocides.

Question: Can you put into context "dose" and "threshold" in terms of low level effects?
Response (Geisy): The idea of a "low dose" [for a particular EDC] can be confounded by the existence of multiple chemicals. There is some confusion about dose and threshold - some agents don't have an effect below a threshold. The trouble comes in the statistical interpretation of when an effect is discerned.
(Wade): Also, related to potency, some chemicals, such as 17-beta-estradiol can exhibit activity at very low does. Human fetuses are already on a dose-response curve because of exposure to natural hormones during pregnancy. He cited a statistic that a fourth child is much less likely to develop testicular cancer than is a first born. Added exposure from chemicals adds to the existing risk.

Question: What is the current research on low dose effect or no affect at higher dose?
Response (Wade): Effects seem to be demonstrated below dose levels, however, these relationships have yet to be confirmed - they are difficult to reproduce.
(Geisy): Related to nonylphenol and fish, he has seen "U" shaped curves - in trying to interpret effects based on potency and concentration of NP, the potency was much lower by itself than the natural hormone, but the existence of the NP appears to have increased the concentration of the natural hormone.

Comment: One participant asserted that SOLEC consider advocating the use of the "precautionary principle" as it relates to endocrine disrupting chemicals, as opposed to waiting for the results of a lengthy and uncertain process of evaluating EDCs.

Comment: Another participant argued that SOLEC is not the appropriate venue to advocate use of the precautionary principle. *Long after the meeting ended, this topic continued to be discussed. It was apparent that participants were irreconcilably divided about this issue and wanted SOLEC organizers to be aware of it. It was specfically requested by one participant that the organizers have a discussion about the applicability of the precautionary principle as it relates to EDCs.*

Comment: One of the participants asserted that more work needs to be done to evaluate what kinds of additional controls could be implemented at waste water treatment facilities.

Comment: In response to a discussion about pulp and paper discharges containing EDCs, one of the pulp and paper industry representative questioned whether enough was known to draw conclusions about the endocrine disrupting effects of pulp and paper process effluent. He asked whether evidence existed to show that reduced gonad size affects a fish's ability to reproduce; whether reduced gonad size occurs in all cases of exposure to EDCs; and that because pulp and paper effluents are not estrogenic that whatever may be causing the observed effects are unlikely to be of bleach plant origin.

Comment: One participant offered an opinion that SOLEC should continue to discuss indicators and should also continue to present information about Endocrine Disruptors.

5.5 Memorable Quotes

The following quotes were heard within the SOLEC 2000 breakout sessions and captured by the session recorders.

1. Regarding indices: "If you mix apples, pears, bananas and grapes, then what will you get besides fruit salad?"
2. Regarding the creation and use of indices for decision-making purposes: "Resistance is **NOT** futile!!"
3. Regarding indices: "How we use the numbers/indicators scares me."
4. Regarding indices: "We have not considered the social issues."
5. Regarding indices: "One Index for the Great Lakes?"
6. From the general human health session: "Has the fetus become the unfortunate mining canary of the 1990's?"
7. From the swimming advisory session: "Managers need to know their beaches."
8. From the fish consumption advisory session: "The way we are doing things, with different advisories all over the place, it screams inefficiency."
9. From the societal session: "Either drop the Societal Indicators, or do something."
10. From the Hamilton Harbour Area of Concern session: "Water in Hamilton Harbour is clean."
11. From the Hamilton Harbour Area of Concern session: "Water and treated wastewater is not cheap."
12. From the Hamilton Harbour Area of Concern session: "Pay 1 cent per 25L of tap water versus $15 per 25L of bottled water, versus $85 per 25L of beer."
13. From the Hamilton Harbour Area of Concern session: "City water has to meet standards, bottled water does not."
14. Regarding indicators: "'MEGO' - My eyes glaze over - in relation to too much information from indicators."
15. Regarding the Biodiversity Investment Areas: "We've been focussing on degraded areas - now we have to pay attention to high quality areas as well."

6. SOLEC 2000 Success Story Recipients

The SOLEC Steering Committee believes that it is important to recognize organizations within the Great Lakes basin that have demonstrated a strong commitment to the environment. For SOLEC 2000, the following criteria were used to select the award recipients:

- Showed improvement in the Great Lakes Ecosystem;
- Forged linkages among economy, environment, and community;
- Created a "win-win" situation;
- Formed strong partnerships;
- Established sustainability as a goal;
- Fostered broad stakeholder involvement; and
- Demonstrated adequate monitoring of effectiveness.

The seven organizations that were selected as SOLEC 2000 Success Story recipients, were chosen based on the above criteria.

Ontario's Environmental Farm Plan

Over 85% of Ontario's farmland is in the Great Lakes basin, and there has been a history of cooperation with the Ontario farm community on Great Lakes water quality management programs. The Environmental Farm Plan (EFP) is a highly successful partnership engaging over 30 farm organizations under the umbrella Ontario Farm Environmental Coalition, together with a number of federal and provincial agencies with responsibilities relating to agriculture, natural resources and environment. Under the EFP, farmers voluntarily attend two workshop sessions in the course of completing a workbook and developing an environmental action plan for their farm. To date, 7389 farmers have completed action plans. Innovative technologies are being developed and implemented on farms throughout the Great Lakes basin. Farmers see opportunities for the adoption of sustainable farm practices that improve the environment and enhance economic viability. Improvements in local ecosystems such as reduced pesticide residues and nutrient loadings to Great Lakes tributaries are a result of this plan.

Saginaw Bay Watershed Initiative Network

The Saginaw Bay Watershed Initiative Network (SBWIN) is a voluntary, non-regulatory partnership that was launched in 1996 to protect and enhance the quality of life in this watershed. SBWIN is a partnership between Dow Chemical and the Saginaw Bay Watershed communities, and is facilitated by the Conservation Fund. Over 90 resource group members are involved with SBWIN and 13 area foundations work together as a Network to support various projects. This network has brought people and resources together to balance environmental, economic, social, recreational, and historic priorities, and leverage ideas and resources toward a common goal - the greater good of future generations. SBWIN has launched projects to protect habitat, improve access to the bay, foster nature-based tourism, inform people about non-point source pollution, and support sustainable agriculture. SBWIN has also initiated the development and implementation of numerous sustainable development plans encompassing both the entire watershed and individual communities within this watershed.

Rural Water Quality Program

The Rural Water Quality Program (RWQP) provides financial assistance to farmers implementing projects to improve water quality in priority surface and groundwater areas in the Regional Municipality of Waterloo, Ontario. Types of projects approved by the RWQP include clean water diversion, manure storage, nutrient management plan, milk house drain, fencing, erosion control, buffer strip, fuel storage, and cover crops. Certain practices (e.g., strip cropping, nutrient management plans, stream buffer strips and fragile agricultural land retirement) are also eligible for performance incentives. This program has received strong support from other jurisdictions outside of the Region. Numerous municipalities, conservation authorities, provincial government agencies, and farm groups have praised the program in terms of the variety of projects supported, the link to the Environmental Farm Plan, and the extent of partners involved in program design and development. This program acts as a model for similar programs in other areas of the Province. Over the past two years, the RWQP has prevented an estimated 4,700 kilograms of phosphorus from reaching local rivers and creeks. Over 60% of this reduction is attributed to nutrient management planning.

Ontario Power Generation
Ontario Power Generation (OPG) will plant 1.6 million native trees and shrubs over the next five years as part of its carbon sequestration program. This will sequester in the order of 560,000 tons of CO_2 over the lifetime of the trees. Tree planting and carbon sequestration efforts can offset greenhouse gas emissions, while OPG pursues other technological solutions and alternative energy generation. The value of combining tree plantings for carbon sequestration with habitat restoration work for the conservation of biological diversity, is tremendous. Strategically planting appropriate native species can achieve both greenhouse gas offsets and address important regional recovery efforts for species that are in need of our help through habitat restoration. This program exemplifies how industry can be successfully engaged in the pursuit of sustainability and the triple bottom line of economy, environment and social benefits. OPG demonstrates that industry can act as a catalyst for the enhancement of long-term ecosystem health.

Tip of the Mitt Watershed Council
Formed in 1979, the Tip of the Mitt Watershed Council is a nonprofit corporation whose purpose is to protect and enhance water resources, including inland lakes, the Great Lakes, streams, rivers, wetlands, and groundwater. The Watershed Council promotes these goals through education, water quality monitoring, monitoring activities that could impact water quality, supporting sound environmental policy at all levels, technical services, and providing capacity building consultation to other organizations. The Watershed Council programs focus on providing essential information and forming partnerships with landowners, local businesses, and government. The Watershed Council operates many programs that serve to protect water resources and aquatic habitats. The Biotechnical Shoreline Erosion Control Program began in 1994 and has prevented 270 tons of sediment from entering the Great Lakes basin to date. These programs have a powerful synergistic effect that can serve as a model for other initiatives.

Xerox
In the early 1990's Xerox made a commitment to become a Waste-Free company. The Xerox Waste-Free goal states: "Waste-Free products, manufactured in Waste-Free factories, that enable our customers to achieve Waste-Free offices." That commitment by Xerox has resulted in programs that reduce waste through entire product life cycle - during manufacturing, use by customers and at product end-of-life. The program includes four critical elements including: sustainable product design, re-manufacture and parts reuse, return programs and efficient use of paper. Xerox has achieved a 90% reduction in solid waste to landfills, 90% reduction in air emissions, and a 90% reduction in hazardous waste. In 1999, the equipment and parts re-manufacturing and recycling program prevented more than 145 million pounds of material from entering landfills. The program provides cost savings to Xerox, its customers, and the community at large. Xerox also publishes "Business Guides to Waste Reduction and Recycling" to share its experience gained through the Waste-Free office goals. The Waste-Free factory is an ongoing commitment and will increase focus on reducing waste generation. One way that Waste-Free factory goals are implemented is through pervasive use of environmental management systems. All of Xerox' major manufacturing operations

worldwide are registered to the ISO 14001 environmental management standard.

Hamilton Harbour Remedial Action Plan

The Hamilton Harbour Remedial Action Plan (HHRAP) was completed in 1991. Various representatives, including citizens, academics, landowners, and representatives from government agencies, municipalities, environmental organizations and industry, formed the RAP Stakeholder group. Hamilton Harbour's problems were addressed on a number of fronts; water quality, access and aesthetics, urbanization and land management, bacterial contamination, stresses on fish and wildlife, and toxic contamination. The HHRAP has some notable successes to date including improvement in water quality, creation of fish and wildlife habitat, increase in public access and protection of the watershed. The Bay Area Restoration Council (BARC) is an incorporated, non-profit, charitable organization established in 1991 to promote, monitor and assess the implementation of the HHRAP. BARC's roles include increasing community involvement, public outreach, and assessing the implementation of the RAP. To date, BARC has involved over 1200 volunteers in activities that help in the clean up and restoration of Hamilton Harbour. BARC's largest event to date involved 625 volunteers for a planting project at the new Hamilton Harbour Waterfront Trail. The trail has increased public access to the harbour and has created new habitat areas for fish and wildlife. BARC encourages citizens to participate in volunteer activities and educates the community about the clean up efforts at Hamilton Harbour.

7. Conference Closing Remarks

John Mills
Regional Director General
Environment Canada, Ontario Region

Frank Lyons
Regional Administrator
U.S. Environmental Protection Agency, Region 5

Delivered on Thursday, October 19, 2000

[JOHN] This is my fourth SOLEC, and I really feel that SOLEC has come of age. This is the most successful SOLEC to date, because of three factors. In my opinion, these are the highlights. First, the substantive content that we heard gives us a sharp focus around the indicator work. Our thanks go to all the presenters and the Steering Committee for their hard work and dedication. Secondly, the participation was impressively broad and again our thanks. Thirdly, the organization of this SOLEC was exceptional, and we would particularly like to recognize the efforts of two individuals who actually conceived SOLEC, have breathed into it and kept it on track: Paul Horvatin and Harvey Shear.

[FRANK] This is my first SOLEC. During the time I have been here, I have been very impressed with the dedicated efforts of all individuals who have made this conference such a raging success. What we have heard over the last three days is very encouraging. A diverse group of committed partners is working to assess the health of the Great Lakes. These efforts are crucial. They allow decision makers and responsible agencies to set goals and priorities, adjust them where necessary, and measure results.

We have three things that we want to talk to you about this afternoon: commitment, the importance of partnerships, and SOLEC itself.

[JOHN] First, commitment.
SOLEC started out as an experiment – a bench scale test if you like. It grew into the pilot stage in 96-98 and now, it is a mature process but it is still a work in progress. At SOLEC 1998, we talked about the Parties' commitment. By our collective efforts, from then until now, we have demonstrated that commitment. The momentum in the room is an indicator of this. And, I can assure you, the federal government will continue to be major players in the Great Lakes program. We commit to take what we've heard and learned here and integrate it into our programs, and we encourage other partners to do likewise. We will be discussing our plans for future SOLECs at our upcoming Bi-national Executive Steering Committee meeting in Chicago in December. We welcome the offer of support from the U.S. Fish and Wildlife Services as we heard last night and we invite those of you who are on the outskirts of this stage of the SOLEC process to join us at centre stage, so that we will have and can implement, the best set of indicators that we possibly can.

[FRANK] Last SOLEC we challenged the Great Lakes community to "take the indicators on the road", and obtain buy-in and uptake from a broader audience. This SOLEC demonstrates that we have indeed done that - the representation here at SOLEC 2000 is exceptionally diverse and broad – we are extremely pleased about that. Secondly, partnerships are essential to meet our objectives. This has been that most engaging SOLEC to date. We have seen more substantive representation from a diverse group of stakeholders. We would like to recognize the presence of First Nations and Tribes and thank them for their participation and contributions at this conference. Especially, the contributions of Henry Lickers and Elder Norm Jacobs. This conference has demonstrated the importance of work at the local level. It has also reinforced the message that governments cannot do this work alone.

[JOHN] The third thing I want to talk about is SOLEC. Science is more than just data – we must share knowledge from community, First Nations and Tribal peoples and embrace it into our thinking. This way, we can create balanced and sustainable partnerships. Both western science and naturalized knowledge systems recognize that knowledge is more than science. We need to take the best from all worlds in constructing and implementing SOLEC indicators. The possibilities of a beneficial relationship between the LaMP and SOLEC indicator processes were demonstrated here today with our Lake presentations. It was exciting for me to see the integration and the "win-win" that exists between SOLEC, LaMP, RAP fisheries plans and other processes. With this SOLEC we have together set up the framework for success, but as I mentioned earlier, we need to keep working at it, to build a formula for success.

[FRANK] Let me say in closing how deeply we appreciate the commitment, dedication and knowledge that you all bring, to the task of restoring the physical, chemical and biological integrity of the Great Lakes basin ecosystem. There are many uncertainties in this effort of course. But, we can state with total certainty, that we will only succeed if we work together in partnership. Federal governments, states, provinces, Tribes and First Nations, municipalities, grass roots organizations, and industry must all be players.

[JOHN] Thank you for coming and have a safe trip home. We look forward to your continuing participation and contributions to build a solid base of indicators that we can use for reporting against the state of the Great Lakes, and for the next State of the Lakes report, which will be published in 2001. We will continue to strengthen and build the SOLEC partnership to implement indicators. As individuals and collectively, we have much to contribute, so, with apologies to Nancy and Paul, make sure that you restore SHEMO to health and "Don't let your good ideas float by on a banner attached to a cream pie".

Now I would like to invite Norm Jacobs to give us a closing Thanksgiving prayer.

Note: the Thanksgiving prayer can be found on the following page. The following paragraphs are a summary of the closing remarks made by Norm Jacobs after the Thanksgiving prayer. These have been paraphrased - sincerest apologies to Mr. Jacobs if the meaning has been misconstrued.

Thanks to SOLEC organizers for inviting First Nations and Tribes to participate in the conference and to be a part of it. The conference shared a lot of what can be done.

When I came, I had commented that we were extending our hands in friendship. Now, talking about indicators – when you can take someone's hand, that's an indicator – but we don't shake it with our right hand, we shake with our left hand, so close to the heart. (Mr. Jacobs invites Harvey Shear and Paul Horvatin to the stage and shakes hands with both of them.)

When we look at what we did contribute, we've not given credit to the agricultural products, no acknowledgment. We're not just freeloaders – we pay taxes.

We're offering our knowledge, what we know, we've lived here since time immemorial.

deyoihwadogęhdǫ́h ganǫhǫ́nyǫhk
short version thanksgiving address

nę:dah nigękyǫhgoˀdę́ gjihswadǫhǫhsi:yǫ́hs gaihwagę:gǫ́h sawá:dǫˀ
now this assembled crowd you will all listen again to my responsibility it has become again

né:ˀ hęjidwaihwagyęhgǫ́ˀ ahǫgwayadihsˀǫ́h ǫgwa:wí: ganǫhǫ́nyǫhk
it we will pull from again our creator he has given us thanksgiving

ne:ˀné:ˀ ag:ˀwe:sáhtˀ agę:nǫ́ˀ dwęnǫhdǫ́nyǫh
it is rejoiceable of well being we are in mind of

ne:ˀdiˀnéˀ ędwe:hék i:ˀhyá:ˀ sgá:t ęjidwayę́:ˀ ogwaˀnigǫ́ha
and so we will in thought we first as one we will put again our minds

sgá:t dęjidwadatnǫhǫnyǫ́:ˀ
as one we will greet each other

netogyę́: é:ˀ niyohtǫ́k ǫgwaˀnigǫ́haˀ
be it so again remain our minds

---

da:né:ˀ ę́:ˀ ęjidwa:tro:wíˀ ahę́h ohwęjádeˀ
now this again we will talk again about existing earth

dwano:hắˀ dedwanǫhǫhkwáˀ né: gwatóh ahę́h niyéha:ˀ
our mother we refer to it as and also what she holds

ne:ˀdiˀnéˀ ędwe:hé:k gwe:gǫ́h dęjidwanǫhǫnyǫ́:ˀ *
and so we will in thought everything we will thank again

netogyę́: é:ˀ niyohtǫ́k ǫgwaˀnigǫ́haˀ
be it so again remain our minds

da:né: é:ˀ ędwa:tró:wiˀ hodęihǫdǫ́nyǫˀ
now it again we will talk about his assigned duty performers

tatihsnyé:gyeˀs shęh nahawayęnánhe
they look after how much he created

neˀdiˀnéˀ ędwe:hék sgá:t dęjetinǫhǫ́nyǫ:ˀ
and so we will mentally as one we will thank them again

netogyę́: é:ˀ niyohtǫ́k ǫgwaˀnigǫ́haˀ
be it so again remain our minds

---

da:né: é:ˀ ęjidwa:tro:wí sedwagowa:nę́h sganyadai:yoˀ
now it again we again will talk about our leader handsome lake

oi:howa:nę́h atatrihwá:daˀa:ˀ
a great worthy commendation he had earned for himself

né:ˀ desahaihwaę:twáht shę́h naęsaǫgwayęhę́k ohę:dǫ́: haˀwęhnihfradenyǫ́:gyeˀ
it is he who has seeded the news of how we will conduct ourselves in future days ahead

neˀdiˀnéˀ ędwe:hé:k dętsedwanǫhǫnyǫ́:ˀ sedwagowanę́h sganyadaiyoˀ
and so we will mentally we will again thank him our leader handsome lake

netogyę́: é:ˀ niyohtǫ́k ǫgwaˀnigǫ́haˀ
be it so again remain our minds

---

da:né: é:ˀ jidwa:tro:wíˀ geí: niyǫgweda:gé: hadiǫhyaˀkió:nǫˀ
now it again we will again talk about the four people of male inhabitants

né: deyǫkhiyęˀnyadǫ́ˀ sgęnǫ́ˀ dwęnǫhdǫ́nyǫh
it is with their hands guard us well being we are in their minds

neˀdiˀnéˀ ędwehé:k dęjetinǫhǫnyǫ́:ˀ hadiohyaˀkio:nǫˀ deyǫkiyęˀnyádǫˀ
and so we mentally we again will thank them heavenly male inhabitants our guardians

netogyę́: é:ˀ niyohtǫ́k ǫgwaˀnigǫ́haˀ
be it so again remain our minds

da:né:ʔ é:ʔ gịjidwa:tro:wíʔ haǫhaʔgéh gaǫhyadę́ʔ hanagrę́ʔ shǫgwayadíhsʔǫh
now it again we will again talk about him who in heaven he lives creator

ne:ʔtsǫ́: toʔsęhdǫ́h nę́ʔ sgęnǫ́ʔ aidwęnǫhdǫ́nyǫ:ʔ
only things dropped down well being in our minds

neʔdiʔnę́ʔ ǫdwe:hé:k dętsedwanǫhǫnyǫ́:ʔ gaǫhyadę́ʔ hana:gręʔ shǫgwayadíhsʔǫh
and so we will mentally again thank him who in heaven he lives our creator

netogyę́: é:ʔ niyohtǫ́k ǫgwaʔnigǫ́haʔ
be it so again remain our minds

da:netóh nǫsaga:tgwe:ní iʔgéh sagayagęhdáhk ganǫhǫ́nyǫhk
this is the best I could do again up to me it again came out thanksgiving

da:nétoh
that is all

Address and Cayuga-English translation provided by
Norman L. Jacobs
Haudenosaunee Environmental Delegate
Six Nations of the Grand River

Appendix A. Conference Agenda

The conference agenda for SOLEC 2000 can be found on the next two pages.

SOLEC 2000

What's it all about?

As Parties to the Great Lakes Water Quality Agreement, the governments of Canada and the United States are responsible for accurate reporting on the state of the Great Lakes. The State of the Lakes Ecosystem Conference is a result of this commitment to reporting. With the establishment of a consistent suite of ecosystem indicators, the health of the Great Lakes basin can be objectively assessed. Regular reporting of a core set of indicators will promote more efficient and successful management as well as creating more accessible information for policy makers and the public.

The first two conferences in 1994 and 1996 developed a series of *ad hoc* indicators to evaluate the state of various Great Lakes ecosystem components. SOLEC 98 went beyond the previous SOLECs and presented a comprehensive list of ecosystem indicators for review and discussion. This suite of indicators objectively represents the state of the Lakes while establishing consistent biennial reporting.

SOLEC 2000 will begin to assess the state of the Great Lakes using the indicators. Future SOLECs will report on the complete suite of indicators. SOLEC 2000 will examine the human health issues of swimmability, drinkability and fishability, and will explore the development and use of ecological indices.

SOLEC 2000

Steering Committee

Steering Committee members represent a wide variety of agencies from around the Great Lakes:

Agency for Toxic Substances and Disease Registry
Council of Great Lakes Industries
Environment Canada
Great Lakes Commission
Great Lakes Fishery Commission
Great Lakes States
Great Lakes United
International Joint Commission
Ontario Ministry of Agriculture, Food & Rural Affairs
Ontario Ministry of Environment
Ontario Ministry of Natural Resources
Tribes/First Nations
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Geological Survey

There are many other individuals and representatives from environmental groups, academia and local governments who have participated in the work necessary to develop this conference.

For additional information please contact:	
Office of Regional Science Advisor Environment Canada - Ont. Region 4905 Dufferin St. Downsview, Ontario M3H 5T4 ph: 416-739-5780 fax: 416-739-4691 e-mail: alison.bloom@ec.gc.ca	Great Lakes National Program Office US EPA 77 West Jackson Blvd., Chicago, IL 60604 ph: 312-353-2087 fax: 312-353-2018 e-mail: madden.molly@epa.gov

SOLEC 2000

State of the Lakes Ecosystem Conference

IMPLEMENTING INDICATORS

October 17, 18, & 19, 2000
Hamilton Convention Centre
Hamilton, Ontario

Hosted by:

Environment Canada
&
United States Environmental Protection Agency

Monday October 16, 2000

An evening reception will take place in the Heritage Room of the Sheraton Hamilton Hotel

Hors d'oeuvres & refreshments provided

Sponsored by Great Lakes Commission

DAY ONE - Tuesday October 17, 2000

Morning
PLENARY: State of the Great Lakes

8:30 Welcome/Opening Ceremonies/Native Greetings

SOLEC Past and Future

State of the Great Lakes: assessment using indicators for the following groupings:
- nearshore and open waters
- coastal wetlands
- nearshore terrestrial and land use
- societal
- human health
  - beach closures
  - drinking water
  - fish contaminants

Great Lakes Index Concept

Lunch and Guest Speaker

Afternoon
CONCURRENT SESSIONS: In-depth Discussions About the State of the Great Lakes. What are the indicators telling us?

Concurrent Sessions 1

Concurrent Sessions 2

5:30 Adjourn

5:30 - 7:30 Poster Session and Mixer

DAY TWO - Wednesday October 18, 2000

Morning
PLENARY: Putting Indicators to Use at the Local Level

8:30 Recap of Day 1 & Overview of Day 2

Biodiversity Investment Area Integration

Putting Indicators to Use: case studies and presentations by local groups

Success Stories: highlights of projects by award receipients

Lunch

Afternoon
CONCURRENT SESSIONS: Indicator Toolbox.
Opportunity to gather more information on the case studies (examples of issues to be discussed: easements, ecological restoration, volunteer monitoring programs, indicators at the local level, fundraising, how to change local governance (zoning), how to keep public interest, GIS approach, industry and community partnerships)

3:00 Adjourn

3:30 Fun Run/Walk and Excursions

Evening
DINNER: Sheraton Hamilton Hotel

6:00 Cash Bar Opens

7:00 SHEMO
Recognition of Success Stories
Dinner
Guest Speaker

DAY THREE - Thursday October 19, 2000

Morning
PLENARY: Lake Ecosystem Status Reports

8:30 Recap Day 2 & Overview Day 3

Lake Presentations

Lunch

Afternoon
CONCURRENT SESSIONS: Cross-cutting Great Lakes Issues & Lake Sessions.
An opportunity to look at each lake in more detail or to participate in special topic sessions.

PLENARY: Commencement

Conference Wrap Up

Native Closing

3:30 SOLEC 2000 Adjourns

3:30-5:30 Meeting rooms available

Please note:

Registration to take place on Mon. Oct. 16, 6:30pm-9:00pm, or Tues. Oct. 17, 7:30am-12noon in the Convention Centre lobby.

For further information on SOLEC visit our web site at
http://www.cciw.ca/solec/
http://www.epa.gov/grtlakes/solec/

Appendix B - Keynote Speakers

Elizabeth Dowdeswell - luncheon keynote speaker, Tuesday October 17, 2000

Elizabeth Dowdeswell's eclectic public service career has spanned provincial, federal and international borders and transcended traditional disciplinary lines. Throughout, her focus has been on engaging the public in public policy-making; seeking innovation in the successful management of organizations through change; and, strengthening communications and education as means to achieve results. Her global vision and pragmatic managerial skills have resulted in a legacy of positive change. This focus continues in her management consulting business.

Ms. Dowdeswell served as Executive Director of the United Nations Environment Programme and Under Secretary General of the United Nations, Assistant Deputy Minister of Environment Canada, responsible for the national weather and atmospheric agency and led a number of public inquiries into such politically sensitive issues as Canada's unemployment benefits program and federal water policy. Her early career included terms as Deputy Minister of Culture and Youth for the Province of Saskatchewan, educational consultant, university lecturer and high-school teacher.

Benjamin Tuggle - dinner keynote speaker, Wednesday October 18, 2001

Benjamin N. Tuggle, Ph.D.
Chief, Division of Habitat Conservation
U.S. Fish and Wildlife Service

In 1997, Dr. Benjamin N. Tuggle became the Chief, Division of Habitat Conservation, for the U.S. Fish and Wildlife Service. He administers National program activities associated with Federal activities; wetland and upland habitat protection; restoration and conservation; wetland mapping; Coastal Barrier Resources Act and other related conservation issues. He provides Service Policy direction for activities under Fish and Wildlife Coordination Act, NEPA, Clean Water Act, Federal Power Act, Coastal Barrier Resources Act and other related conservation laws for which the Service has specific responsibilities.

Previous to his current position, Dr. Tuggle served as the Field Office Supervisor, Chicago Illinois Field Office, U.S. Fish and Wildlife Service. During this time, 1991 through 1997, he was detailed to Washington. D.C., Capital Hill, to work with the Committee on Merchant Marine and Fisheries, House of Representatives as congressional committee staff. From 1985 until 1990 he served as Unit Leader, Grambling Cooperative Wildlife Project, Grambling State University, Grambling, Louisiana. He also served as Chief of the Research and Diagnostic Parasitology Division, the National Wildlife Health Research Laboratory, Madison, Wisconsin from 1981 to 1985.

Dr. Tuggle received his B.S. in Biology in 1975 from Fort Valley State College, Fort Valley, Georgia. His M.S. and Ph.D. in Zoology was received in 1977 and 1982, respectively; both from the Ohio State University in Columbus, Ohio. He has written a total of 16 publications in 8 referred scientific journals and 3 chapters in a U.S. Fish and Wildlife Service Resource Publication.

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Appendix C - Participant Profile

Country	Number of Attending Delegates	Percent
Canada	268	56.5
United States of America	203	42.8
Mexico	2	0.4
Brazil	1	0.2
Total	**474**	**100**

Sector	Number of Attending Delegates	Percent
Federal Government	146	30.8
Provincial/State Government	68	14.4
Industry	42	8.9
Academia/Research	31	6.5
Environmental Groups	30	6.3
Commissions	29	6.1
Professional Associations/Societies	20	4.2
Native/First Nations	16	3.4
Conservation Authorities	16	3.4
Municipal Government	14	3.0
Public Advisory	13	2.7
Recreation/Conservation	11	2.3
Health	9	1.9
Agriculture	7	1.5
Media	5	1.1
Other	17	3.6
Total	**474**	**100**

Appendix D - SOLEC 2000 Participants List

First Name	Last Name	Agency/Affiliation	E-mail Address
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60

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Appendix E - Participant Feedback

The following information is based on the 64 participant responses to the SOLEC 2000 Evaluation Form with the information being broken down into six main categories.

Key Conference Indicator

The question was asked "Did SOLEC 2000 enhance your ability to preserve, protect and restore the Great Lakes?" Over **40%** of the respondents felt it did with comments such as "lots of solid information available", "new ideas, concepts, tools and techniques to consider" and "improved understanding of status of selected indicators and trends." While only about 10% of the respondents felt that the conference had not enhanced their ability to improve the ecosystem, some of their comments included "need to focus on how to apply political pressure", "information needs to be more digestible for lay-people" and "information was not new or current in many cases."

Plenary

For all three days over **55%** of the respondents felt that the plenary sessions covered their topics well or very well and also that the presentations were useful or very useful. As for the presentations providing new information over **53%** of the respondents felt that the plenary sessions did this well or very well. Some comments included: "assertions were made without supporting data/evidence - this must be avoided in future as it lacks credibility", "the presentations on Day 2 weren't really about using indicators but about local groups collecting their own information and taking action", and in regards to the lake plenary on Day 3 "excellent overall, but would have been nice to see a single slide summarizing the health of all/each Lake based on about 10 indicators".

Breakout Sessions

Twenty-five percent of the respondents felt that the In-depth Indicator breakout sessions covered their topics well or very well with one comment about implementing indicators; "workshops should focus on how to implement indicators into our own work and how to channel our work to a centralized place." The response for the same question increased to **30%** and **34%** for the Indicator Toolbox sessions and the Lake & Cross-Cutting Issues sessions respectively. As for providing new insights and/or information, **42%** of the respondents felt that this was done well or very well in the Indicator Toolbox sessions, **36%** felt this for the In-depth Indicator sessions, while only **22%** felt that the Lake and Cross-Cutting Issues sessions did this well or very well.

When considering the length of the sessions (generally 1.5 hours each), **44%** felt that it was adequate, however comments included: "too many topics in each breakout sessions to cover in the time allotted which resulted in superficial discussion." There were both good and bad comments about the facilitation such as "facilitation at all breakouts attended was first rate" and "breakout moderators need more direction on what the objectives are for the individual breakout sessions. This lack of direction often led to misguided discussion and lack of progress." There was also a comment about the choices the participants faced; "topics for breakout sessions were good, making it difficult to choose which to attend."

Special Features

Sixty-seven percent of the respondents felt that the display and poster session was useful or very useful, with the time being "a good opportunity to network and communicate," although some felt that "more displays should have been allowed" and the poster reception was "too short of a window to speak to poster authors."

The response was mixed for the field trips - **37%** of the respondents found them useful or very useful and would have liked to participate in more than one, however **48%** of the respondents didn't respond to this question but did add comments such as "lose the field trips and let's conduct our business"

General

Over **82%** of the respondents agree or strongly agree that SOLEC is a valuable and vital function. One participant added "SOLEC is an excellent process to share and disseminate scientific research. The process should be continued and funded such that U.S. Environmental Protection Agency and Environment Canada staff can be full supported to advance SOLEC goals." Several suggestions were made to help the organizers improve SOLEC such as "a new participants information session" which could include a discussion about the SOLEC indicator process and decisions made to get to the current suite of indicators. Also, clearer links between SOLEC and LaMP indicators needs to be made.

Over **83%** of the respondents agree or strongly agree that the conference was well organized, and **67%** felt that the conference program was well designed. **48%** of the respondents agree or strongly agree that there was adequate opportunity for participation.

Newsletter

Once again the daily newsletter proved to be a popular piece of information at the conference with **67%** of the respondents agreeing or strongly agreeing that the newsletters were useful and informative.

Appendix F - Lake Huron Indicators (DRAFT)

(Revised version dated Feb 12, 2001. Revisions based on comments received at SOLEC 2000)

The attached table contains a listing of indicators identified as potentially important for Lake Huron. This list was derived from the report: *Selection of Indicators for Great Lakes Basin Ecosystem Health* - Version 4, Appendix 2. The table includes:

- Indicator number and code (CP = Critical Pollutants, F = Fisheries, H = Habitat, O = Other Issues).
- Indicator name,
- What the indicator measures,
- Identification of agency(s) volunteering to be the sponsor of the indicator, and
- Has indicator been proposed for the SOLEC Indicator List (C.R. = Concept Retained in another indicator).

Future consideration must be given to the following factors when final indicators are chosen:

- Is the indicator necessary,
- Is the indicator sufficient, and
- Is it feasible to collect data (monitor) for interpretation of the indicator?

Draft Indicators for Critical Pollutants

Indicator Number	Indicator Name	Measure	Lead Agency	SOLEC Indicator?
CP - 114	Contaminants In Young-of-the-Year Spottail Shiners	Concentration of PBT chemicals in young-of-the-year spottail shiners.		Yes
CP - 115	Contaminants in Colonial Nesting Waterbirds	1) Annual concentrations of DDT complex, PCBs, Dioxins and other organic contaminants and Hg and other metals in Herring Gull eggs from sites in Lake Huron (U.S. and Canada). 2) Periodic measurement of biological features of gulls and other colonial waterbirds known to be directly or indirectly impacted by contaminants and other stressors. 3) Reporting of Saginaw Bay data separate from that of other Lake Huron collection sites.		Yes, with addition of separate reporting of Saginaw Bay data
CP - 117	Atmospheric Deposition of Toxic Chemicals	Annual average loadings of toxic chemicals from the atmosphere to Lake Huron, based on measured atmospheric concentrations of the chemicals, as well as wet and dry deposition rates.		Under Consideration
CP - 118	Toxic Chemical Concentrations in Offshore Waters	The concentration of toxic chemicals in the offshore waters of Lake Huron.		Under Consideration
CP - 1074	Total Suspended Solids	Degradation of phytoplankton and zooplankton, and tributary habitat.		No
CP - 4081	*E. coli* and Fecal Coliform Levels in Nearshore Recreational Waters	Monitoring *E. Coli* at all beaches on Lake Huron and focusing on Saginaw Bay and southeast Lake Huron. Should include 1) Counts of *E. coli* and/or fecal coliforms in recreational waters measured as number of organisms per volume of water and 2) Frequency of beach closings at specific locations.		Yes
CP - 4083	Contaminants in Edible Fish Tissue	Concentration of persistent, bioaccumulative toxic chemicals targeted by the Great Lakes Water Quality Agreement in edible fish tissue. Focus on lake trout and whitefish.		Yes
CP - 4090	Radionuclides	Concentration of H-3 (tritium) in surface water - southeast Lake Huron.		C.R.(4178)

CP - 4142-4158	Organochlorines in human breast milk	Concentrations of organochlorines in breast milk (should include contaminants in blood serum)		No
CP - 4516	Sediment Flowing Into Coastal Wetlands	Suspended Sediment Unit Area Yield (tonnes/km^2 of upstream watershed) for a representative set of existing monitoring sites just upstream of coastal wetlands.		Yes
CP - 8135	Contaminants Affecting Productivity of Bald Eagles	1) Concentrations of DDT Complex, PCB, PCDD, and other organic contaminants and mercury and other heavy metals in Bald Eagle eggs, blood, and feathers; 2) number of fledged young produced; and 3) number of developmental deformities. Should also include osprey monitoring.		Yes, with addition of osprey monitoring
New	Contaminants in Snapping Turtles	Concentrations of persistent, bioaccumulative toxic chemicals in snapping turtles.		No

Draft Indicators for Habitat

Indicator Number	Indicator Name	Measure	Lead Agency	SOLEC Indicator?
H - 6	Fish Habitat	1) Quality and area of aquatic habitat (e.g., shore, spawning shoals, tributaries, wetlands, etc.)		Yes, partial
H - 21	Habitat	Quality and area of nearshore terrestrial habitat (e.g. colonial waterbird nest sites, forest cover, agricultural land, soil types, beach types, etc.).		No
H - 4504	Amphibian Diversity and Abundance	Relative abundance and diversity of calling frogs and toads.		Yes, revised
H - 4510	Coastal Wetland Area by Type	Quality and area of coastal wetlands by type (e.g., dry year/low water level area versus wet year/ high water level area).		Yes, revised
H - 4511	Gain in Restored Coastal Wetland Area by Type	Gain in restored wetland area by type.		Yes
H - 7041	Cottage and second home development	Number of new residences in the nearshore and whether development is under restrictive zoning to protect the nearshore.		C.R.(7002, 7027) revised
H - 7055	Habitat Adjacent to Coastal Wetlands	Land use within 1 kilometer (km) of coastal wetlands.		Yes, revised
H - 8114	Habitat Fragmentation	The pattern of natural habitat remaining within ecoregions/subsections, as measured by 1) area to perimeter ratio; 2) size; and 3) percent intact cover for habitat patches.		Yes, revised
H - 8131	Extent of Hardened Shoreline	Kilometers of artificially hardened shoreline. (Does not include artificial coastal structures such as jetties, groynes, breakwalls, piers, etc.). This should include estimation of area of hardened shoreline that disrupts ecological functions of the shoreline area (e.g., coastal wetlands, dune areas, and eroding bluff areas.		Yes, revised
H - 8149	Protected Nearshore Areas	Percentage of main lake shoreline in protective status. Categorized in one of six International Union for the Conservation of Nature (IUCN) classes: 1) strict protection, 2) ecosystem conservation and recreation, 3) conservation of natural features, 4) conservation through active management, 5) protected landscapes, and 6) managed resource protected areas.		Yes
New	Lake Huron Islands	Island acreage or shoreline protective status.		No
New	Alvars	Area and quality of alvar habitat		No

Draft Indicators for Fisheries and Related Other Issues

Indicator Number	Indicator Name	Measure	Lead Agency	SOLEC Indicator?
F - 6	Fish Habitat	Population of sentinel fish species. For example, the measures for tributary		Yes, partial

		quality could include the number of dams, number of miles of river channel that is impounded, number of miles of (formerly) high-gradient stream channel that is impounded, and the number of miles between the river mouth and the first dam. The number and location of fish passage facilities (up- and downstream) that could be used successfully by species or communities of concern (for example, lake sturgeon, or other anadromous fishes listed in FCGO).		
F - 8	Salmon and Trout	1) Productivity, yield, or harvest of Pacific salmon, rainbow trout and brown trout using abundance (e.g., catch of each species in a given unit of sampling effort), or biomass metrics; and 2) populations of stocked and naturally produced fish.		Yes
F - 9	Walleye and *Hexagenia*	Abundance, biomass, or annual production of walleye and burrowing mayfly (*Hexagenia* spp.) populations in historical, warm-coolwater, mesotrophic habitats of Lake Huron. Presence or absence of a *Hexagenia* mating flight (emergence) in late June- July in areas of historical abundance.		Yes
F - 16	Lake sturgeon	Rehabilitate populations; delist as threatened or endangered species.		No
F - 17	Preyfish Populations	Abundance and diversity, as well as age and size distribution, of preyfish species (i.e., deepwater ciscoes, sculpins, lake herring, rainbow smelt, and alewives) in Lake Huron.		Yes
F - 93	Lake Trout and Scud (*Diporeia hoyi*)	Abundance, yield, or biomass, and self-sustainability of lake trout and scud (*D. hoyi*) in coldwater, oligotrophic habitats of Lake Huron.		Yes
F - 4502	Coastal Wetland Fish Community Health	An Index of Biotic Integrity (IBI) will be developed based on measures of species richness and abundance, percent exotic species, percent phytophils and other appropriate parameters.		Yes
O - 5	Sea Lamprey	Reduce sea lamprey population by 50% by 2000; 90% by 2010		No
O - 109	Phytoplankton Populations	Phytoplankton biomass (species and size composition) and size-fractionated primary productivity (Carbon-14 uptake or photosynthesis) as indicator of microbial food-web structure and function.		Under Consideration
O - 116	Zooplankton Populations	Community composition; 2) Mean individual size; and 3) Biomass and production.		Yes
O - 4501	Coastal Wetland Invertebrate Community Health	Relative abundance of sensitive taxa (e.g., mayflies, caddis flies), tolerant taxa (e.g., Chironomini as a proportion of total Chironomidae abundance, Isopoda), richness of specific taxa, and functional feeding groups (e.g., herbivores, detritivores, carnivores), working towards the development of an Index of Biotic Integrity (IBI).		Yes
O - 4513	Presence, Abundance & Expansion of Invasive Plants	Presence, abundance, & expansion of invasive plants (both native and non-native), such as purple loosestrife and Eurasian water milfoil.		Yes
O - 8161	Threatened Species	Number, extent, and viability of species ranked as GI-G3 or S1-S3 in the Biological Conservation Database.		Yes
O - 9002	Non-native Species: Aquatic	Assess the presence, abundance and distribution of invasive non-native aquatic species in the Lake Huron and tributaries and their impacts on ecosystem functioning. *This indicator is under development.*		Under Consideration
New	Non-native Species: Terrestrial	Assess the presence, abundance and distribution of invasive non-native terrestrial species in and their impacts on ecosystem functioning. *This indicator is under development.*		Under Consideration
New	Intensive Agricultural Operations	Location, frequency of occurrence, potential for impact on ground and surface waters of Intensive Agricultural Operations.		No

Additional Potential Indicators:

- Contaminants in sea lamprey as an indicator of ecosystem health.
- Dissolved oxygen in the nearshore areas as an indicator of fish health.
- Biodiversity index of native species as an indicator of ecosystem health.
- Outdoor recreation opportunity as an indicator of available recreational resources.
- Outdoor recreation as an indicator of development pressure.
- Groundwater quality as an indicator of water quality and potential impact on human health.
- Communication structure as an indicator of the ability to respond critical environmental issues.

For additional information and detailed descriptions of the indicators listed above and additional indicators, see *Selection of Indicators* for *Great Lakes Basin Ecosystem Health* (U.S. Environmental Protection Agency/Environment Canada) at (www.epa.gov/grtlakes/solec/98/indicators).

Please send comments to:
Jim Bredin
Michigan Office of the Great Lakes
bredinj@state.mi.us

SOLEC 2000 Day 1

Day1 | Day 2 | Day 3

Haudenosaunnee
Norm Jacobs
Six Nations of the Grand River
12 pages 3.3Mb

SOLEC History and 10-year Plan:
Paul Horvatin
US EPA Great Lakes National Program Office
12 pages 1.2 Mb

SOLEC Conclusions
Anne Kerr
Environment Canada
4 pages 260 Kb

Overview of the SOLEC Indicator Process
Harvey Shear
Environment Canada

Nearshore and Open Water Indicators
Melanie Neilson
Environment Canada

Land Indicators: Assessing the Effects Of Land Use on The Great Lakes Basin Ecosystem
Victoria Pebbles
Great Lakes Commission

Societal Indicators
F. Henry Lickers
Mohawk Council of Akwesasne

Overview of Human Health in the Great

Lakes Basin
Christopher T. De Rosa
Agency for Toxic Substances and Disease Registry

Human Health: Swimming Advisories
Marcia Jimenez
City of Chicago Department of Environment

Human Health: Drinking Water
Rod Holme
Past President, American Water Works Association

Human Health - Fish Contaminants Indicator
Patricia McCann
Minnesota Department of Health

Great Lakes Indices: A Concept for Discussion
Paul Bertram
US EPA Great Lakes National Program Office

Summary and Charge
Kelly Burch
Pennsylvania Department of Environmental Protection

Day1 | Day 2 | Day 3

deyoihwadogęhdǫ́h ganǫhǫ́nyǫhk
short version thanksgiving address

nę:dah nigękyo̲hgoˀdę́ ęswathaǫhsi:yóhs gaihwaęt:gǫ́h awá:dǫˀ
now this assembled crowd you will all listen to my responsibility it has become

né:ˀ hędwaihwakyę́:to shǫgwayadihsˀǫ́h sǫgwa:wí: ganǫhǫ́nyǫhk
it we will pull from our creator he has given us thanksgiving

ne:ˀné:ˀ aǫ:ˀwe:sáhtˀ sgę:nǫ́ˀ dwęnǫhdǫ́nyǫh
it is rejoicable of well being we are in mind of

ne:ˀdiˀnéˀ ędwe:hék i:ˀhyá:ˀ sgá:t ędwayę́:ˀ ogwaˀnigǫ́ha
and so we will in thought we first as on we will put our minds

sgá:t dędwadatnǫhǫnyǫ́:ˀ
as one we will greet each other

netogyę́: niyohtǫ́k ǫgwaˀnigǫ́haˀ
be it so remain our minds

da:né:ˀ ędwa:tro:wíˀ shę́h ohwęjádeˀ
now this we will talk about existing earth

dwano:háˀ dedwano̲hǫhkwáˀ né: gwatóh shę́h niyéha:ˀ
our mother we refer to it as and also what she holds

ne:ˀdiˀnéˀ ędwe:hé:k gwe:gǫ́h dędwano̲hǫnyǫ́:ˀ
and so we will in thought everything we will thank

netogyę́: niyohtǫ́k ǫgwaˀnigǫ́haˀ
be it so remain our minds

da:né: ędwa:tró:wiʔ   hodęihǫdǫ́nyǫʔ
now it   we will talk about   his assigned duty performers

tatihsnyé:gyeʔs   shęh   nahawayęnánhe
they look after   how much   he created

neʔdiʔnéʔ   ędwe:hék   sgá:t   dęyetinǫhǫ́nyǫ:ʔ
and so   we will mentally   as one   we will thank them

netogyę́:   niyohtǫ́k   ǫgwaʔnigǫ́haʔ
be it so   remain   our minds

da:né: ędwa:tro:wíˀ geí: niyǫgweda:gé: hadiǫhyaˀkió:nǫˀ
now it we will talk about the four people of male inhabitants

né: deyǫkhiyęˀnyadǫ́ˀ sgęnǫ́ˀ dwęnǫhdǫ́nyǫh
it is with their hands guard us well being we are in their minds

neˀdiˀnéˀ ędwehé:k dęyetinǫhǫnyǫ́:ˀ hadiohyaˀkio:nǫˀ deyǫkiyęˀnyádǫˀ
and so we mentally we will thank them heavenly male inhabitants our guardians

netogyę́: niyohtǫ́k ǫgwaˀnigǫ́haˀ
be it so remain our minds

da:né: ędwa:tro:wí sedwagowa:nę́h sganyadaí:yoˀ
now it we will talk about our leader handsome lake

oi:howa:nę́h atatrihwá:dsˀa:ˀ
a great worthy commendation he had earned for himself

né:ˀ desahaihwaę:twáht shę́h naǫsaǫgwayęhę́k ohę:dǫ́:
it is he who has seeded the news of how we will conduct ourselves in future

haˀwęhnihfradenyǫ́:gyeˀ
days ahead

neˀdiˀnéˀ ędwe:hé:k dęsedwanǫhǫnyǫ́:ˀ sedwagowanę́h sganyadaíyoˀ
and so we will mentally we will thank him our leader handsome lake

netogyę́: niyohtǫ́k ǫgwaˀnigǫ́haˀ
be it so remain our minds

da:né:ˀ ędwa:tro:wíˀ haǫhaˀgéh gaǫhyadéˀ hanagréˀ shǫgwayadíhsˀǫh
now it we will talk about him who in heaven he lives creator

ne:ˀtsǫ́: toˀsęhdǫ́h néˀ sgęnǫ́ˀ aidwęnǫhdǫ́nyǫ:ˀ
only things dropped down well being in our minds

neˀdiˀnéˀ ędwe:hé:k dęsedwanǫhǫnyǫ́:ˀ gaǫhyadéˀ hana:gréˀ
and so we will mentally thank him who in heaven he lives

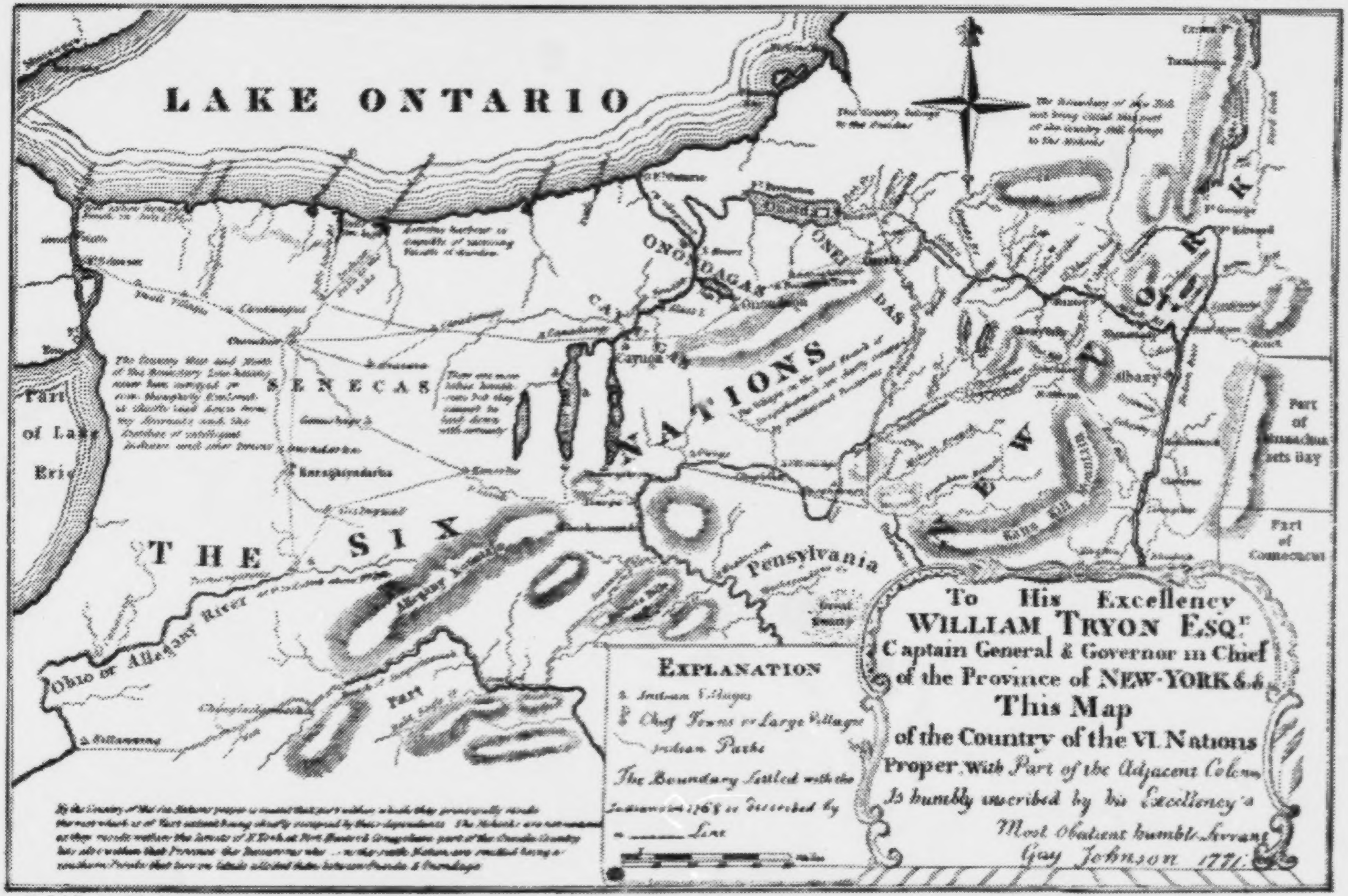
shǫgwayadíhsˀǫh
our creator

netogyę́: niyohtǫ́k ǫgwaˀnigǫ́haˀ
be it so remain our minds

da:netóh	naga:tgwe:ní	iˀgéh	agayagęhdáhk	ganǫhǫ́nyǫhk
this is the best	*I could do*	*up to me*	*it came out*	*thanksgiving*

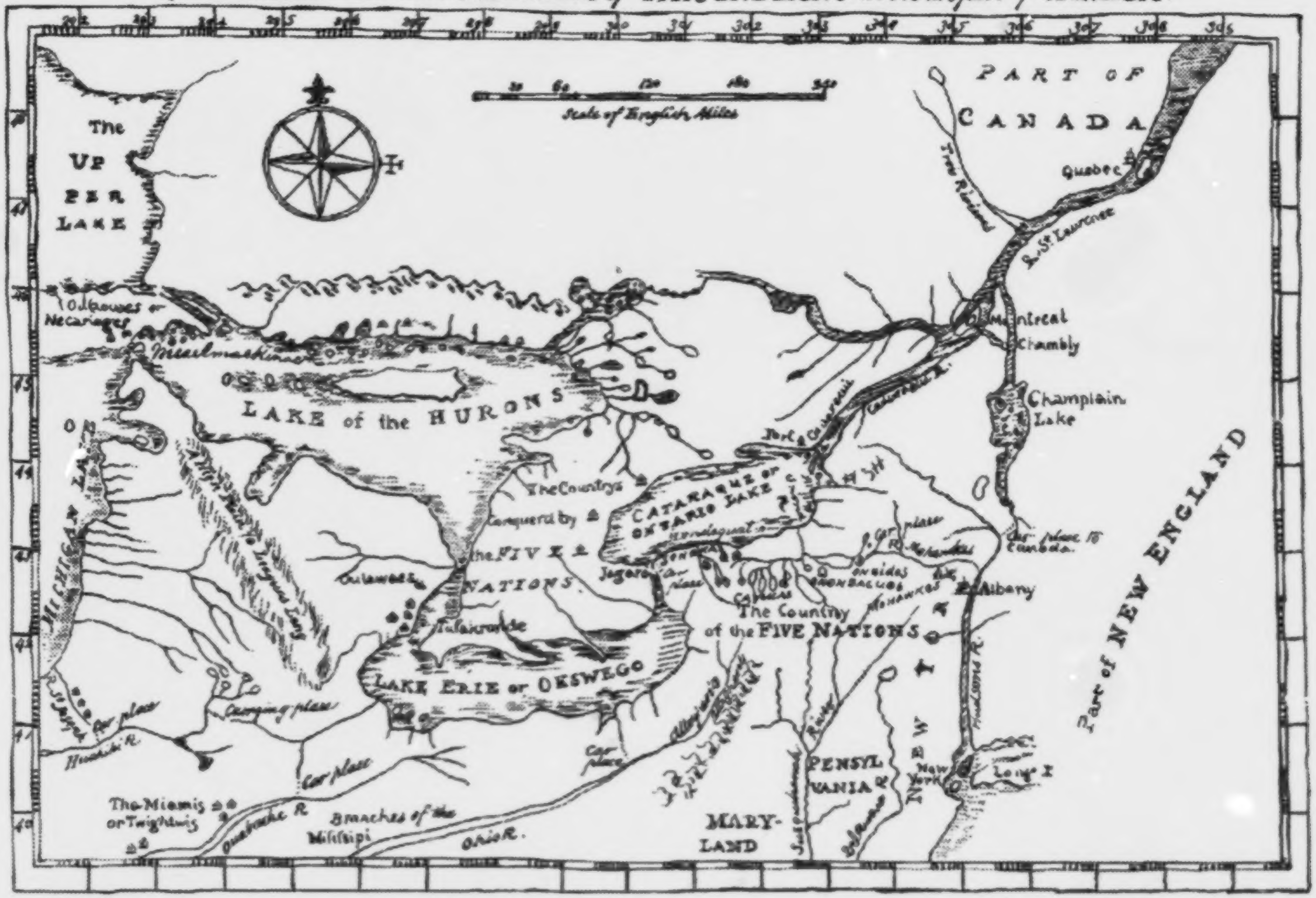
da:nétoh
that is all

MAP OF THE PROVINCE OF NEW YORK, 1771, SHOWING THE COUNTRY OF THE SIX NATIONS.


LAKE ONTARIO
Part of Lake Erie
THE SIX NATIONS
SENECAS
CAYUGAS
ONONDAGAS
ONEIDAS
NEW YORK
Ohio or Allegany River
Pensylvania
Albany
Part of Massachusets Bay
Part of Connecticut
Part
EXPLANATION
Indian Villages
Chief Towns or Large Villages
Indian Paths
The Boundary Settled with the Indians in 1768 is described by Line
To His Excellency
WILLIAM TRYON ESQ.r
Captain General & Governor in Chief
of the Province of NEW-YORK &c. &c.
This Map
of the Country of the VI. Nations
Proper, with Part of the Adjacent Colonys
Is humbly inscribed by his Excellency's
Most Obedient humble Servant
Guy Johnson 1771.

New York Engraving & Printing Co.

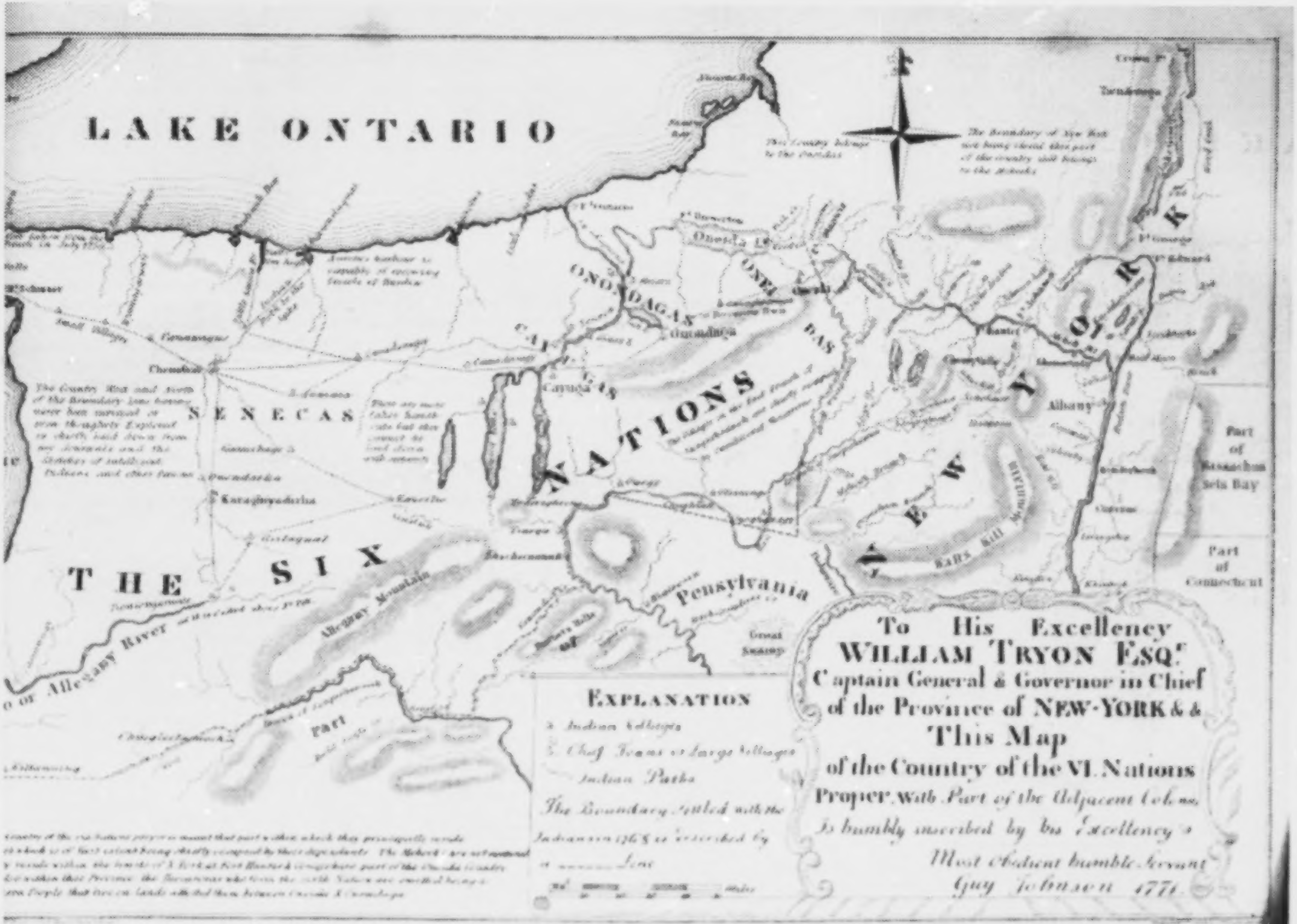
A MAP of the Country of the FIVE NATIONS, belonging to the Province of NEW. YORK; and of the LAKES near which the Nations of FAR INDIANS live with part of CANADA.


PART OF CANADA
Quebec
R. St. Laurence
Trois Rivieres
Montreal
Chambly
Champlain Lake
Scale of English Miles
30 60 120 180 240
The UP PER LAKE
Outawes or Necariages
Misilimakinac
LAKE of the HURONS
MICHIGAN LAKE
The Countrys Conquerd by the FIVE NATIONS
Outawas
Tulakwade
CATARAQUE or ONTARIO LAKE
Jagara
LAKE ERIE or OSWEGO
Oneidas
Onondagues
Cayugas
Mohawks
Albany
The Country of the FIVE NATIONS
Part of NEW ENGLAND
NEW YORK
New York
Long I.
PENSYLVANIA
MARY-LAND
Camping place
Car place
Branches of the Misisipi
Ohio R.
The Miamis or Twightwis
Ouabache R.

N.B. The Tuscaroras are now reckond a sixth Nation & live between the Onondagues & Oneidoes; & the Necariages of Misilimakinac were received to be the seventh Nation at Albany, May 30th 1723 at their own desire 80 men of that Nation being present besides women & children

Reproduction of old map of country occupied by the Five Nations, for report on the Six Nations of New York.

Eleventh Census: 1890


LAKE ONTARIO
THE SIX NATIONS
SENECAS
CAYUGAS
ONONDAGAS
ONEIDAS
NEW YORK
Oneida L.
Cayuga
Onondaga
Albany
Kats Kill Mountains
Allegany Mountain
Allegany River
Pensylvania
Great Swamp
Part
Part of Massachusets Bay
Part of Connecticut
To His Excellency
WILLIAM TRYON ESQ.r
Captain General & Governor in Chief
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This Map
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Proper, With Part of the Adjacent Colonies
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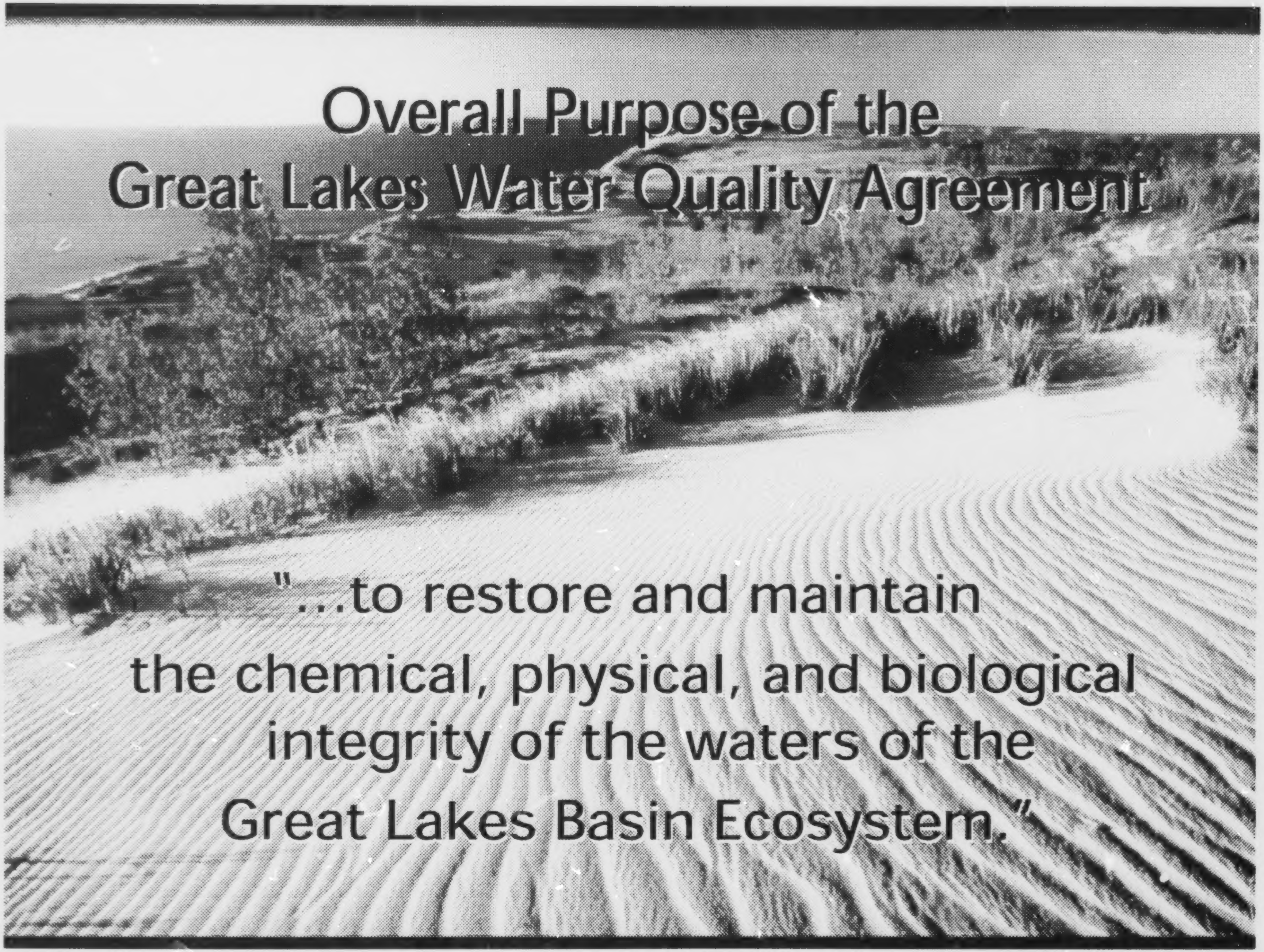
EXPLANATION
Indian Villages
Chief Towns or Large Villages
Indian Paths
The Boundary settled with the Indians in 1768 is described by a Line

SOLEC History
and
10-year Plan

Paul Horvatin

US EPA

Great Lakes National Program Office



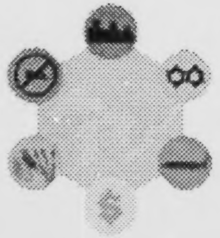
Overall Purpose of the Great Lakes Water Quality Agreement

"...to restore and maintain
the chemical, physical, and biological
integrity of the waters of the
Great Lakes Basin Ecosystem."

SOLEC Objectives

- Assess the state of the Great Lakes ecosystem based on accepted indicators
- Strengthen decision making and management
- Inform local decision makers of Great Lakes environmental issues
- Provide forum for communication and networking among all stakeholders

SOLEC Themes

1994  State of the Great Lakes

1996 The Nearshore Environment
and Land Use

1998 Great Lakes Indicators
& Biodiversity Investment Areas

2000
SOLEC 2000
IMPLEMENTING INDICATORS
Implementing Indicator Reporting
(Human Health Focus)

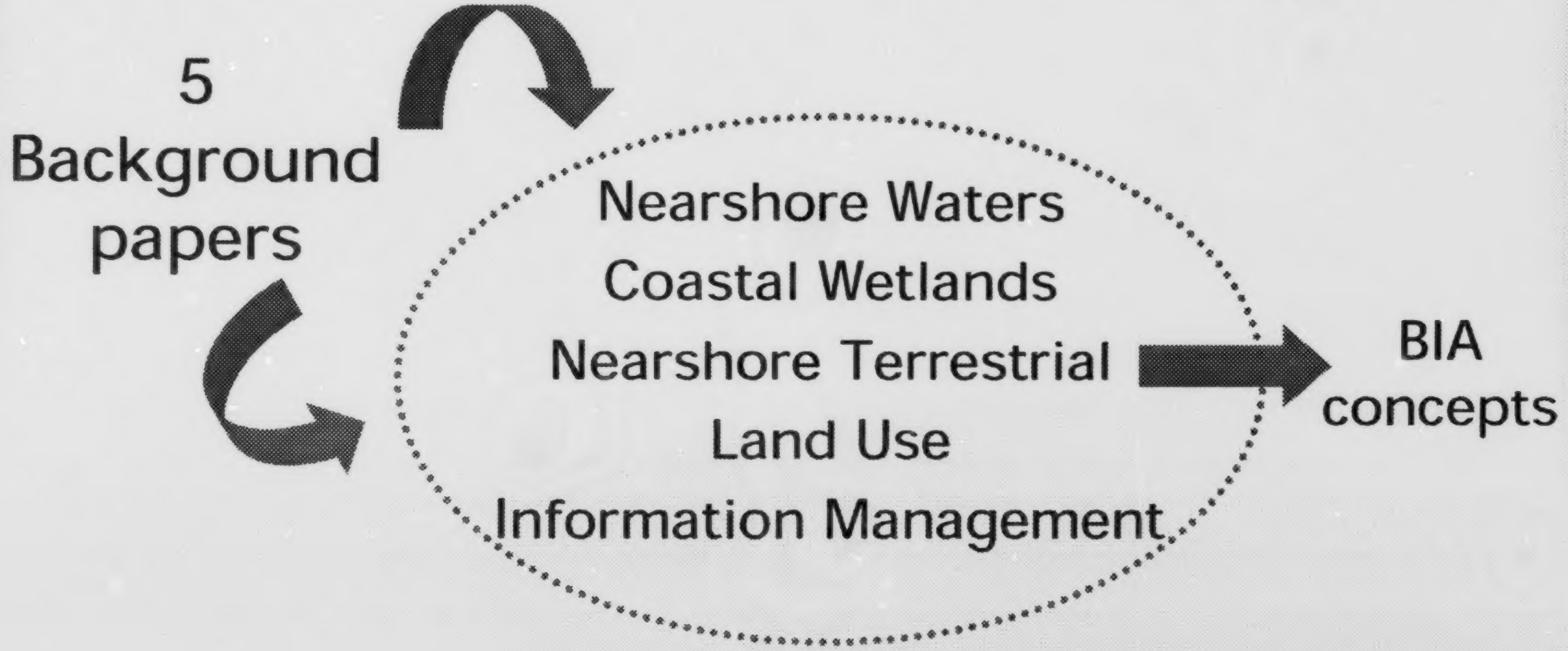
SOLEC '94

Aquatic Ecosystem Health
Human Health
Aquatic Habitat and Wetlands
Nutrients
Contaminants
Socio-economic Stresses

SOLEC Products

- 6 Background papers
- 1 State of the Lakes Report (1995)
- 1 Report on Highlights

SOLEC '96



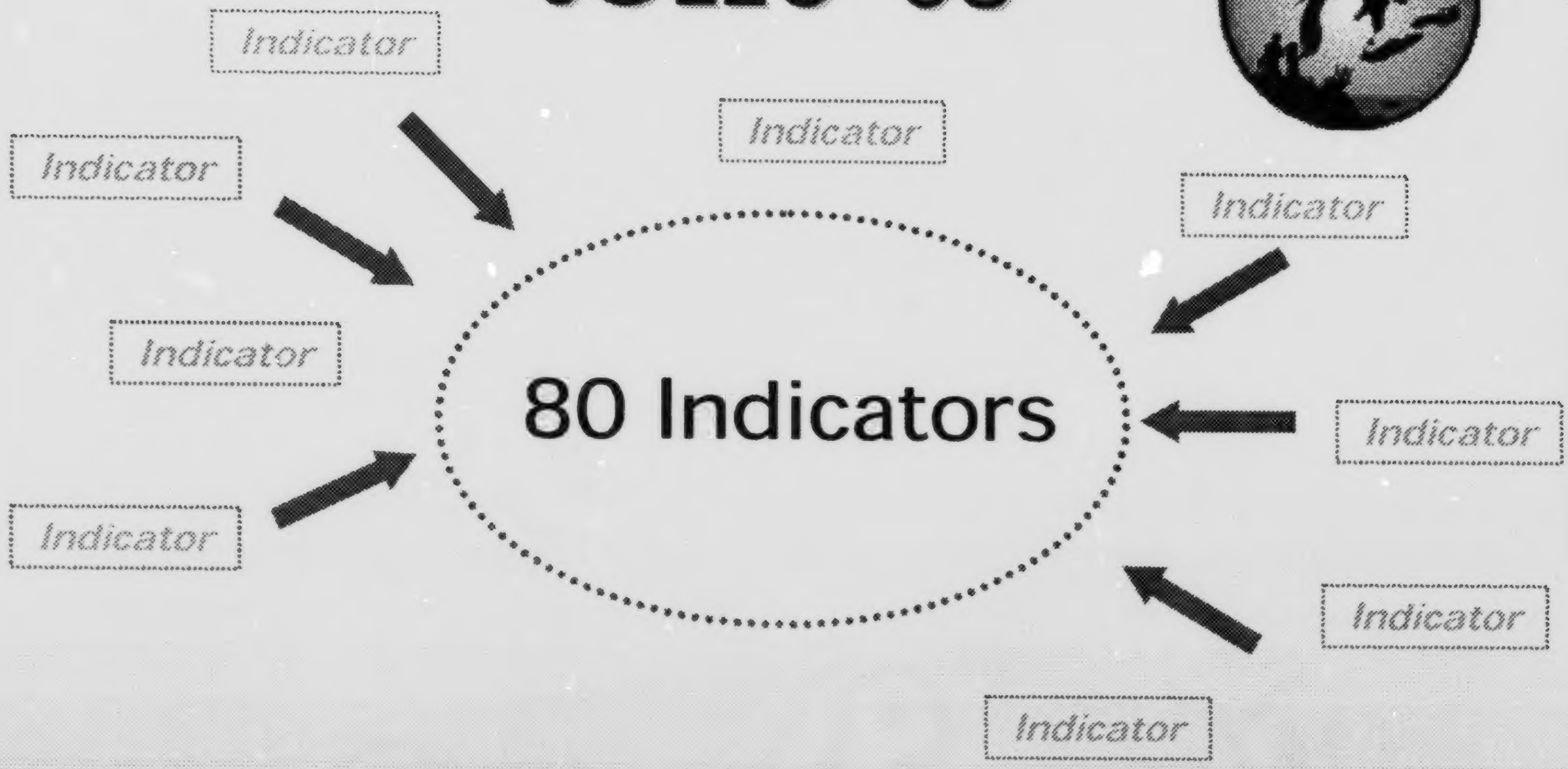
5 Background papers

Nearshore Waters
Coastal Wetlands
Nearshore Terrestrial
Land Use
Information Management

BIA concepts

SOLEC Products
- 1 State of the Lakes Report (1997)
- 1 Report on Highlights

SOLEC '98



Indicator

Indicator

Indicator

Indicator

Indicator

Indicator

Indicator

Indicator

Indicator

80 Indicators

SOLEC Products

SOLEC Indicators

SOLEC '98

Biodiversity Investment Areas →

Nearshore Waters
Coastal Wetlands
Nearshore Terrestrial

SOLEC Products

- SOLEC Indicators
- 3 Biodiversity Investment Areas Papers
- 1 Great Lakes Indicators Database
- 1 Great Lakes Indicators Selection Report
- 1 State of the Lakes Report (1999)

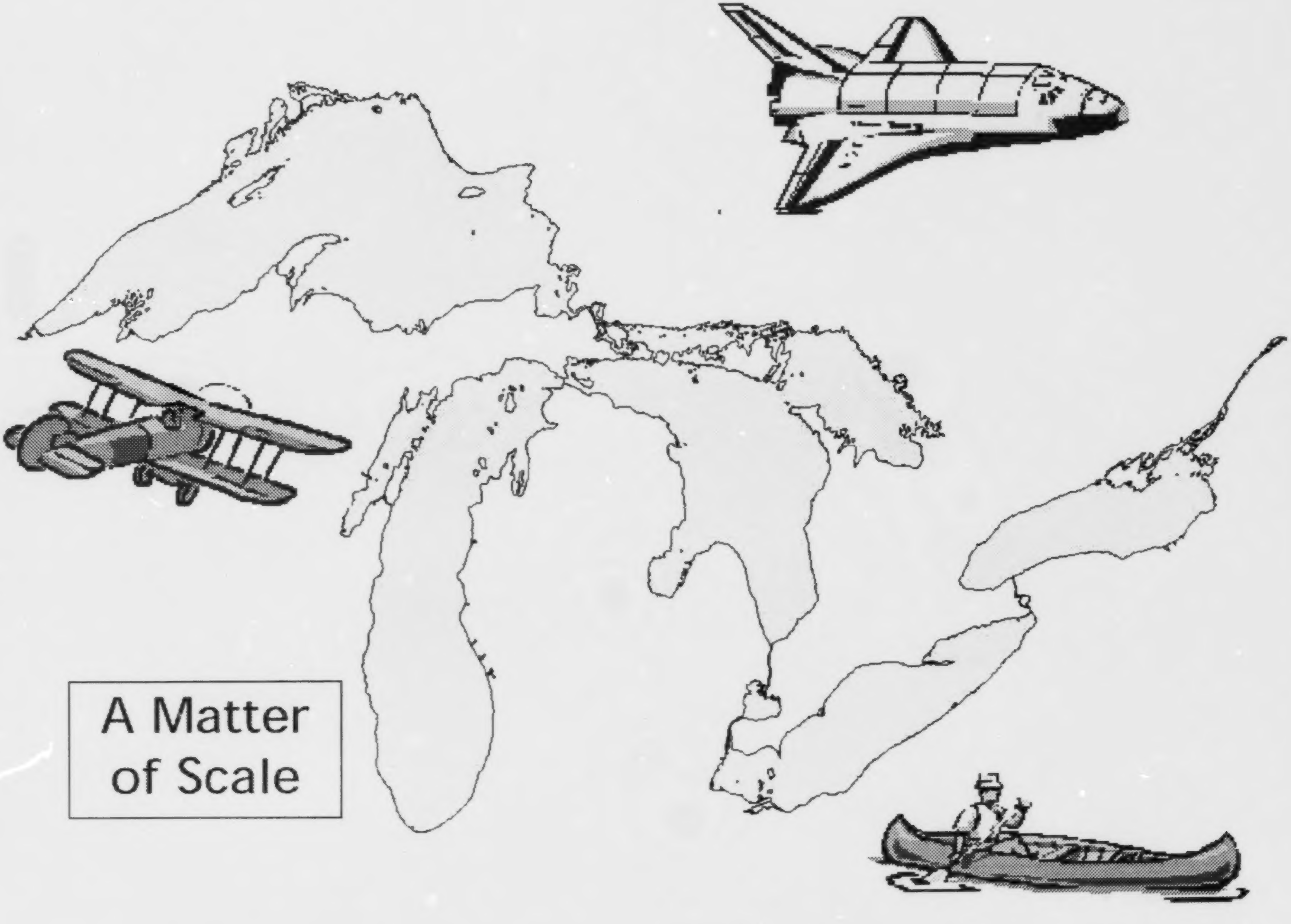
SOLEC 2000

SOLEC Indicators
Human Health Focus
Putting Indicators to Use
Lake Ecosystem Status
BIA Integration

***Future* SOLEC Products**

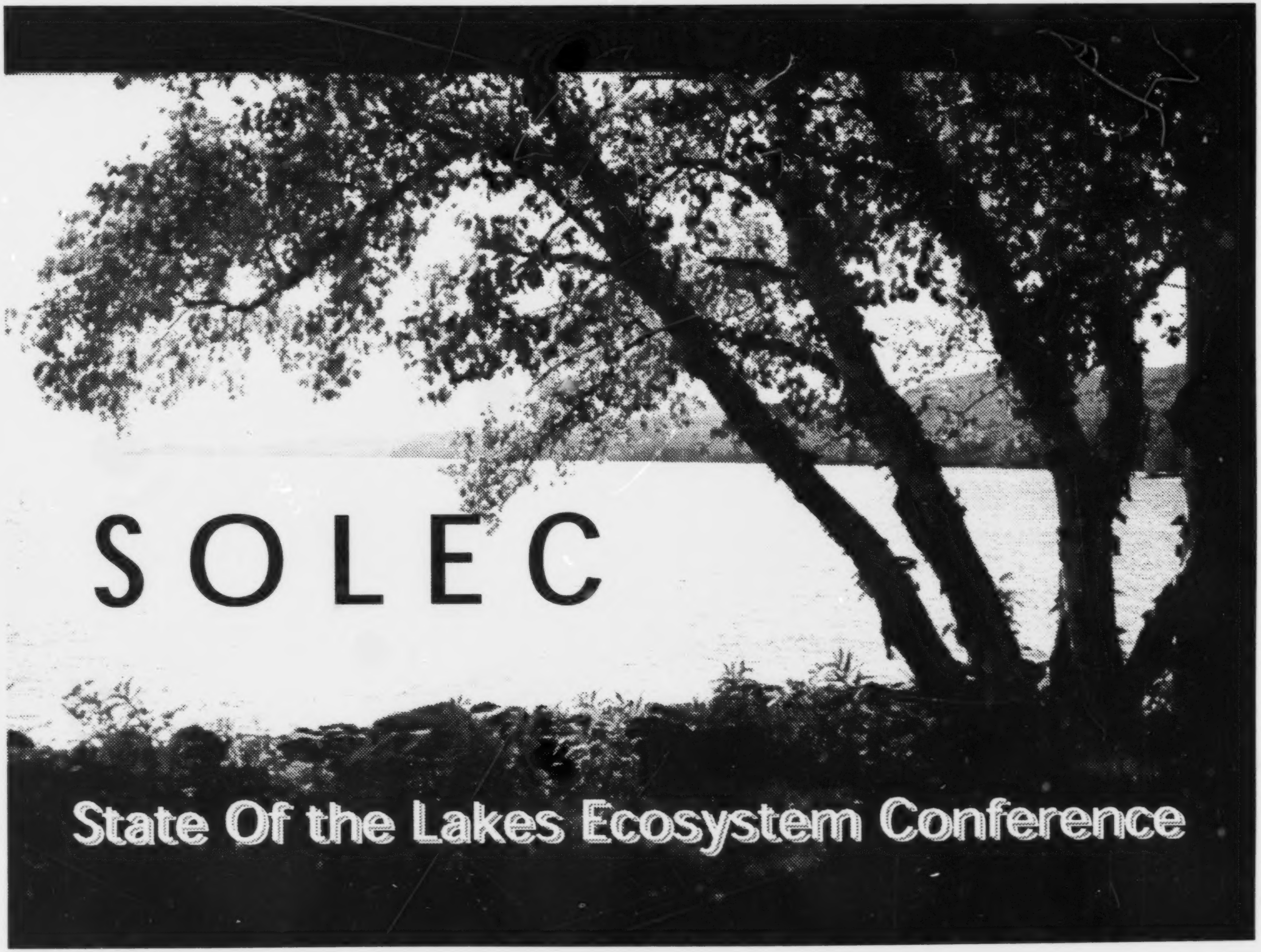
- Indicators Report
- Biodiversity Investment Area Integration
- Paper: State of the Great Lakes 2001

A Matter of Scale



SOLEC in the FUTURE...

2001	*Scoping Workshops*
2002	SOLEC: Biological Integrity
2003	*Scoping Workshops*
2004	SOLEC: Chemical Integrity
2005	*Scoping Workshops*
2006	SOLEC: Physical Integrity
2007	*Scoping Workshops*
2008	SOLEC: Theme to be determined



SOLEC

State Of the Lakes Ecosystem Conference

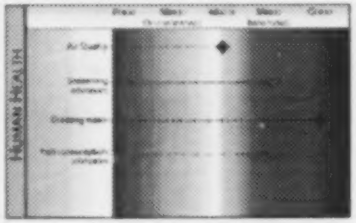
SOLEC CONCLUSIONS

Anne Kerr

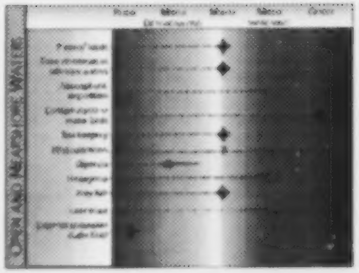
Environment Canada

5 Major groups of indicators

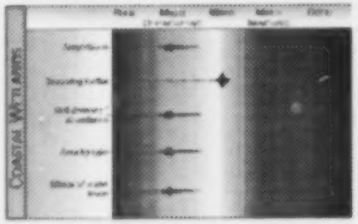
- Human Health



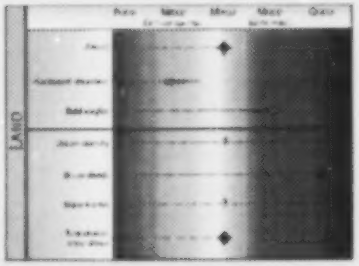
- Open and Nearshore Waters



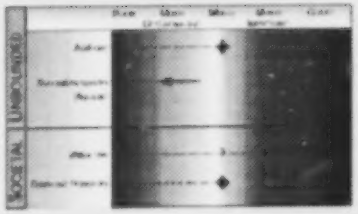
- Coastal Wetlands



- Land

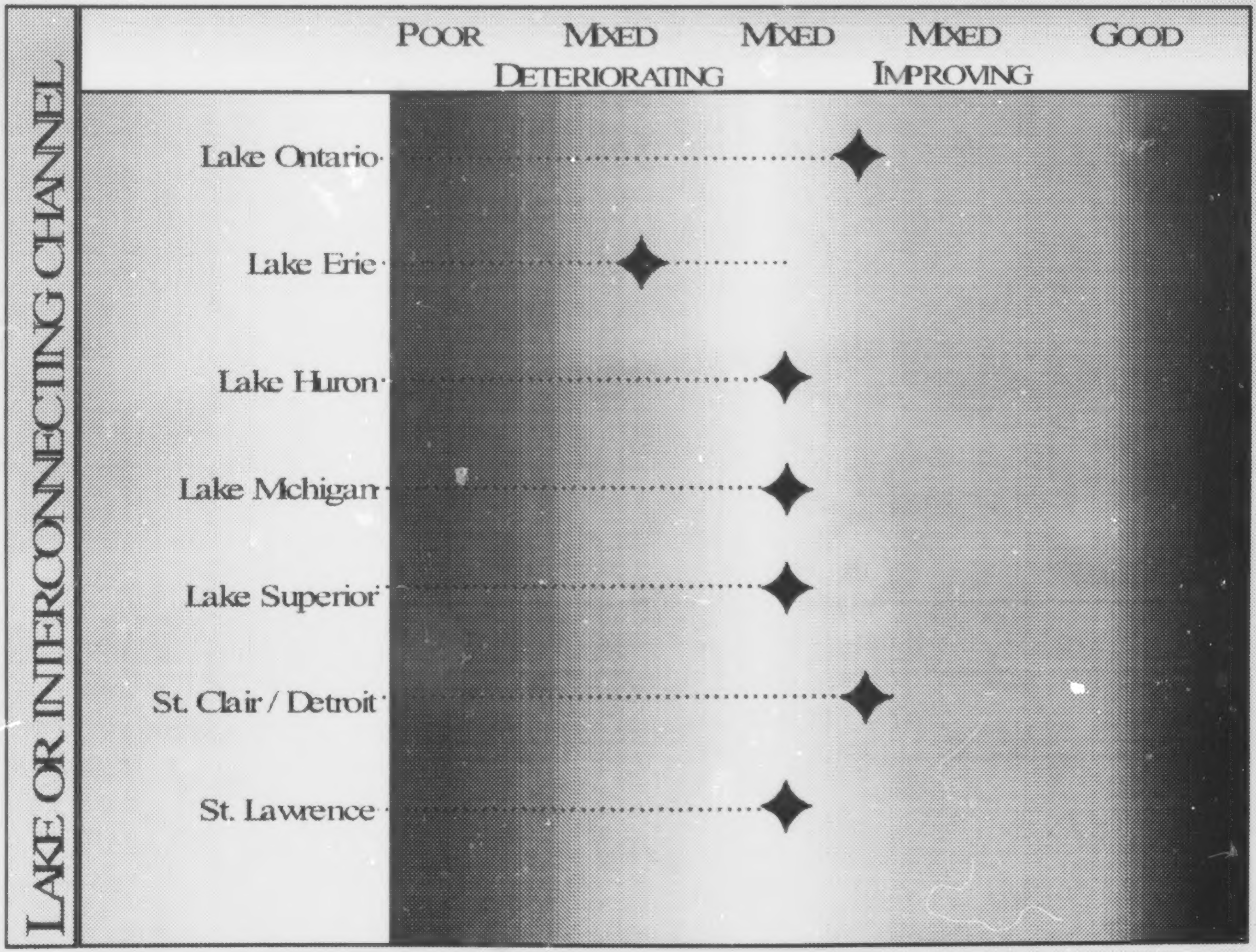


- Societal/Unbounded



Biodiversity Investment Areas

Lake or Interconnecting Channels



Overview of the SOLEC Indicator Process

Harvey Shear

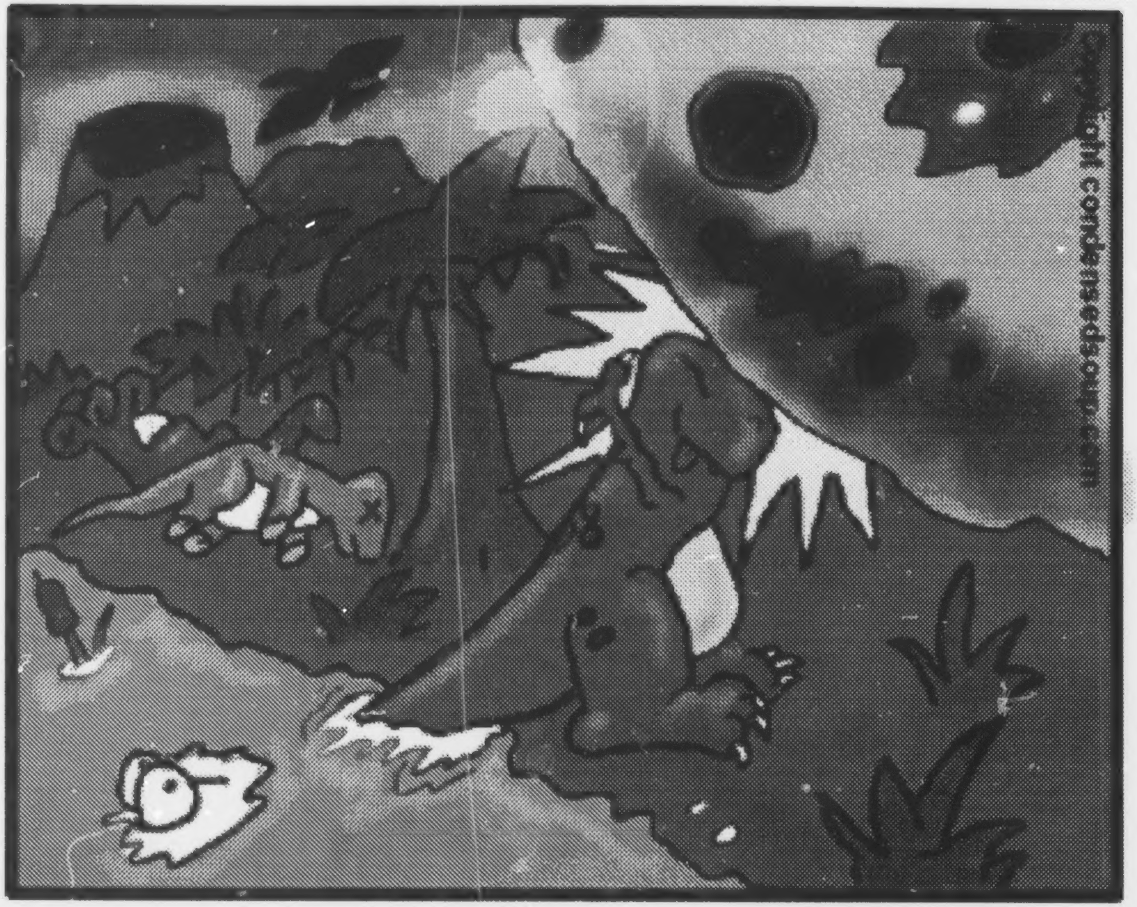
Environment Canada

Great Lakes Water Quality Agreement

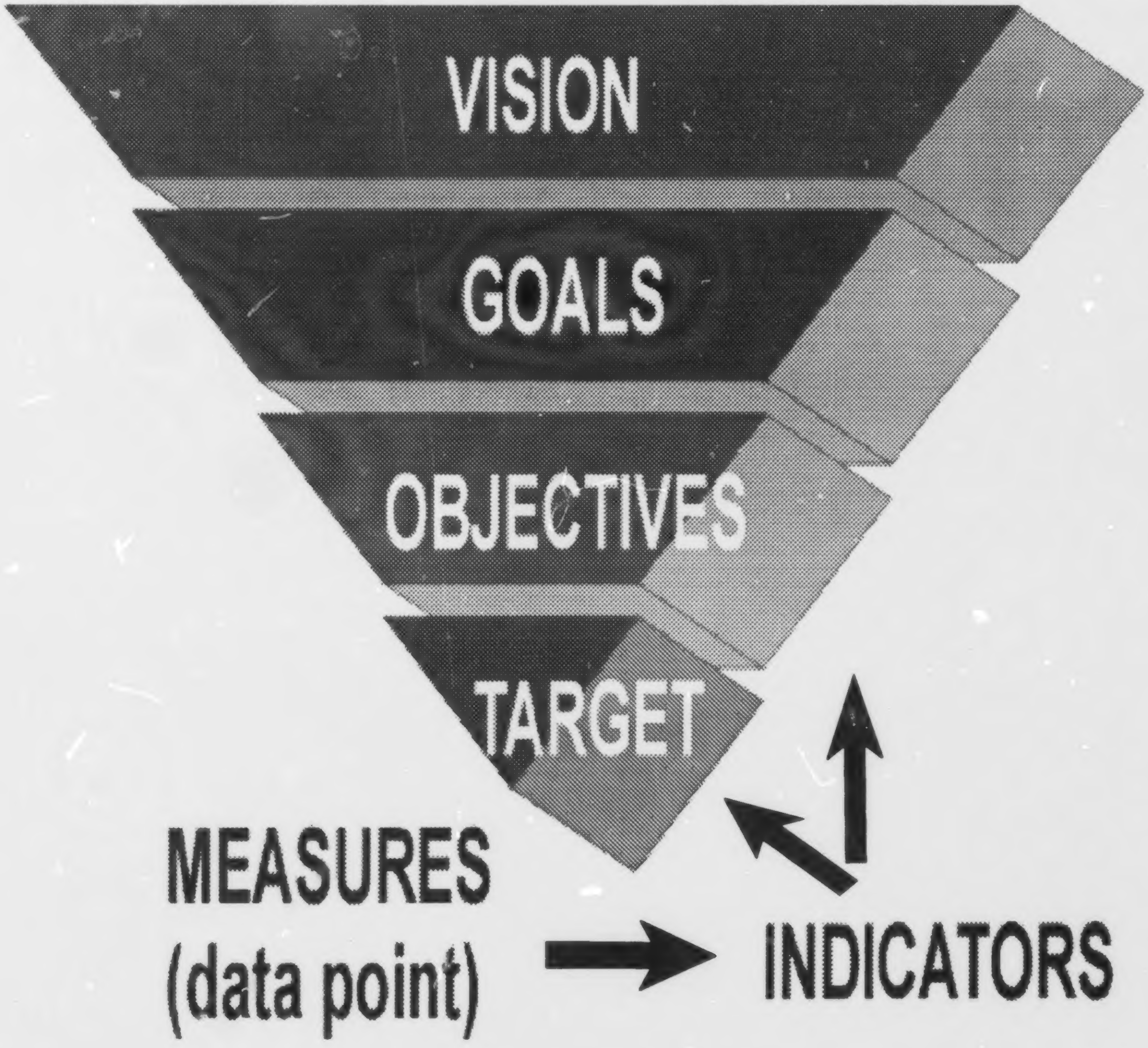
- 1987 Protocol to GLWQA
  - Lake ecosystem objectives and ecosystem health indicators

- SOLEC indicators are based on sound science....

There’s Science and There’s Sound Science…



Scientists have discovered that the moon is moving away from the earth at a tiny yet measurable distance every year. If you do the math, you can calculate that 85 million years ago the moon was orbiting the earth at a distance of about 35 feet from the earth's surface. This would explain the death of the dinosaurs. The tallest ones, anyway....



VISION

GOALS

OBJECTIVES

TARGET

MEASURES
(data point)

INDICATORS

What Is an Indicator List?

A compilation of indicators

- *necessary*
- *sufficient*
- *feasible*

to characterize the state of the Great Lakes ecosystem

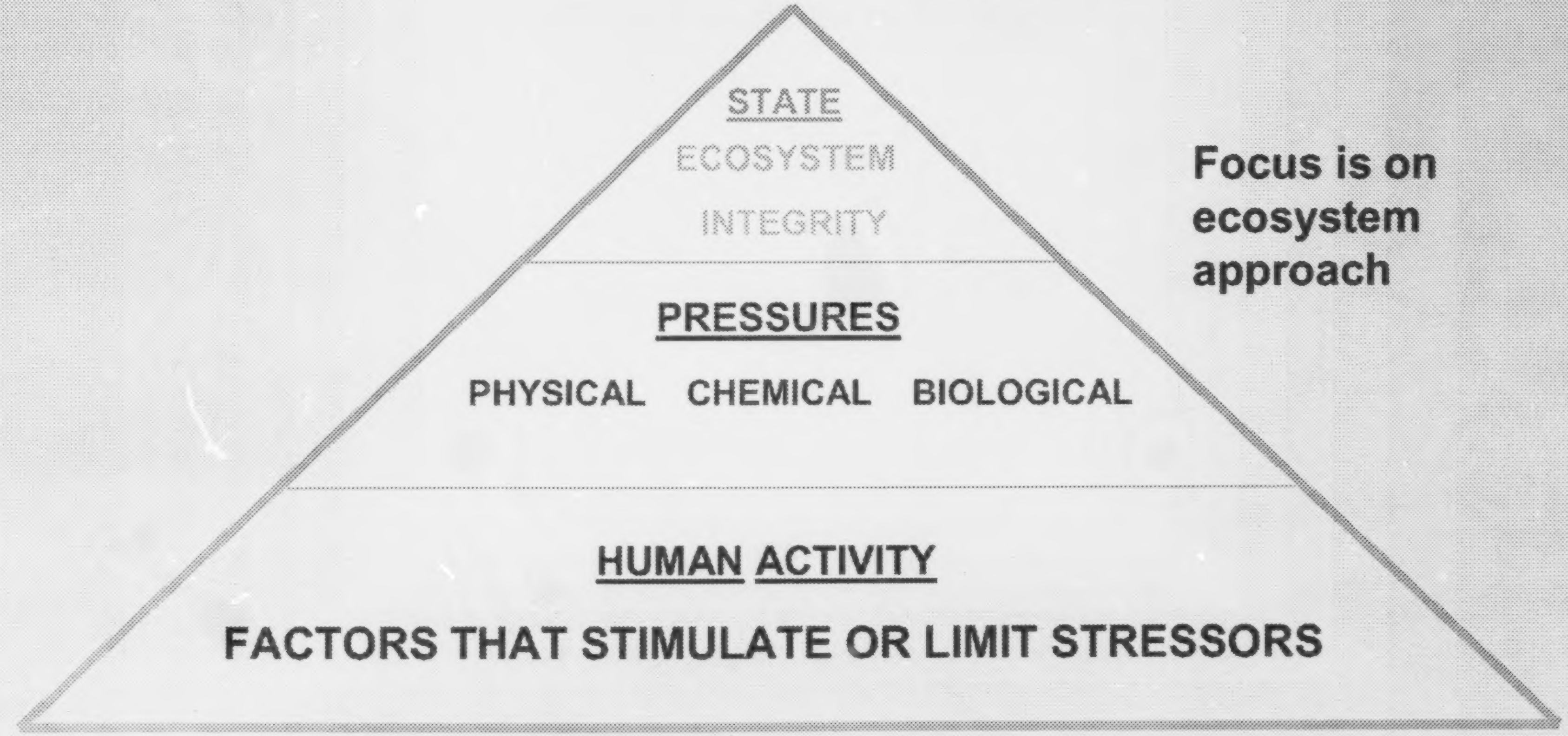
Why Create an Indicator List?

- Gives an overview of conditions in the Great Lakes
- Provides consistency of information
- Leads to efficient allocation of resources
- Reach consensus on information needed

The Indicator Selection Process

- Used State-Pressure - Human Activity model
- Indicators are interconnected
  - e.g. Wetland area / wetland bird diversity and abundance

Indicator Framework: State, Pressure, and Human Activity



STATE

ECOSYSTEM

INTEGRITY

PRESSURES

PHYSICAL CHEMICAL BIOLOGICAL

HUMAN ACTIVITY

FACTORS THAT STIMULATE OR LIMIT STRESSORS

Focus is on ecosystem approach

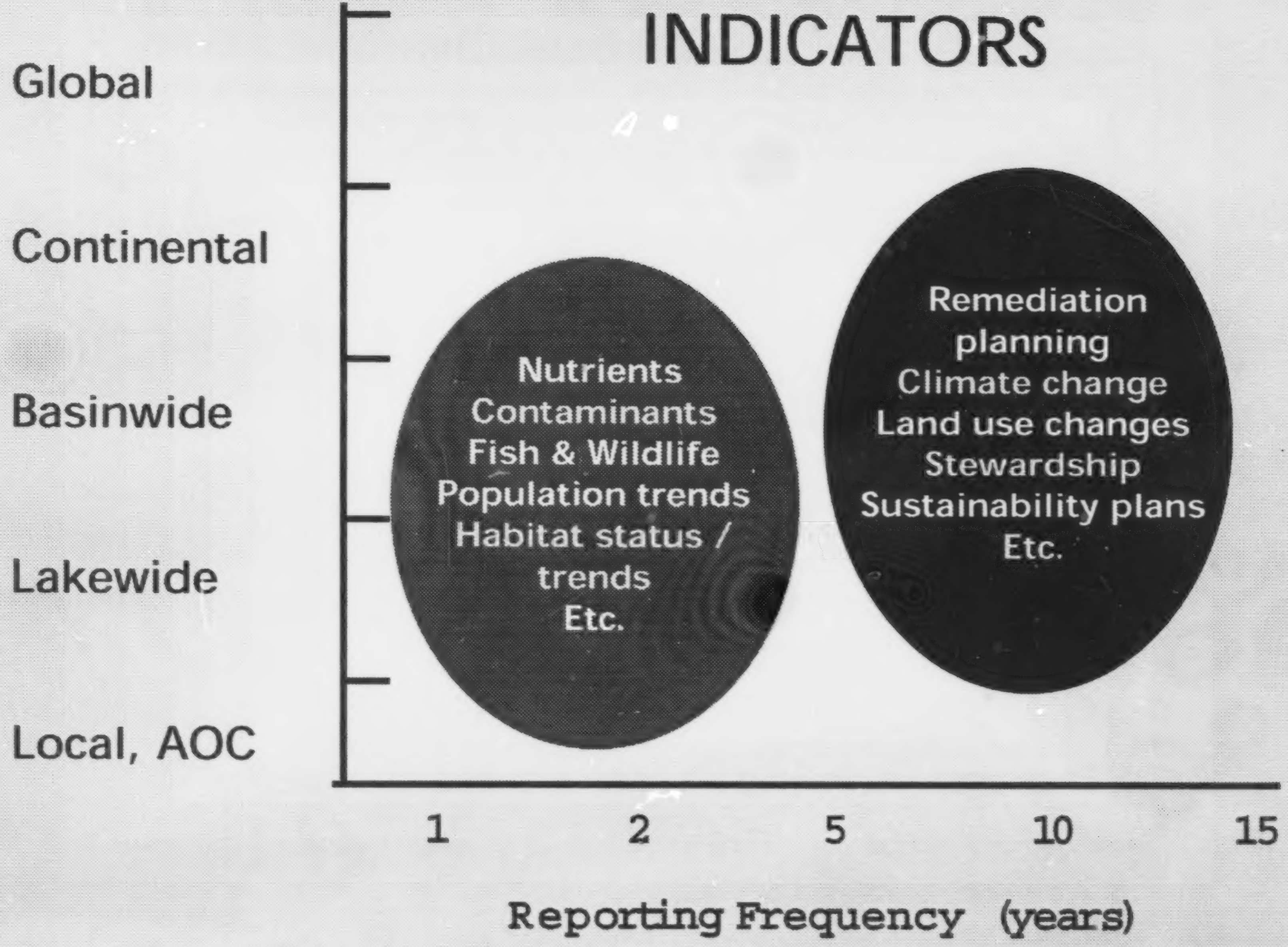
The Indicator Selection Process

- Over 850 possible existing indicators considered
- Scientific review reduced the list to 80
- Presented and discussed at SOLEC 98
- Indicator list revised and sent out for review May 1999
- Version 4 of list online
- Indicator list is evolving; it is not static

The Indicator Selection Process

- Indicator categories are based on the ones presented in 1998
- SOLEC process is open
- SOLEC list is in transition
- Indicators for inland areas have not been dealt with yet
- Indicators need end points

INDICATORS



Global

Continental

Basinwide

Lakewide

Local, AOC

Nutrients
Contaminants
Fish & Wildlife
Population trends
Habitat status / trends
Etc.

Remediation planning
Climate change
Land use changes
Stewardship
Sustainability plans
Etc.

1 2 5 10 15

Reporting Frequency (years)

How Did We Get to This Point?

- Experts put together short summaries for 31 indicators
- Writers and presenters were asked to assess the indicators

Development of Indices

- Aggregate indicators - eventually report out on 10-20 indices rather than 80 indicators
- A sample of 2 proposed indices will be presented this morning
- Future work on indicators will lead to the development of additional indices

Morning Details

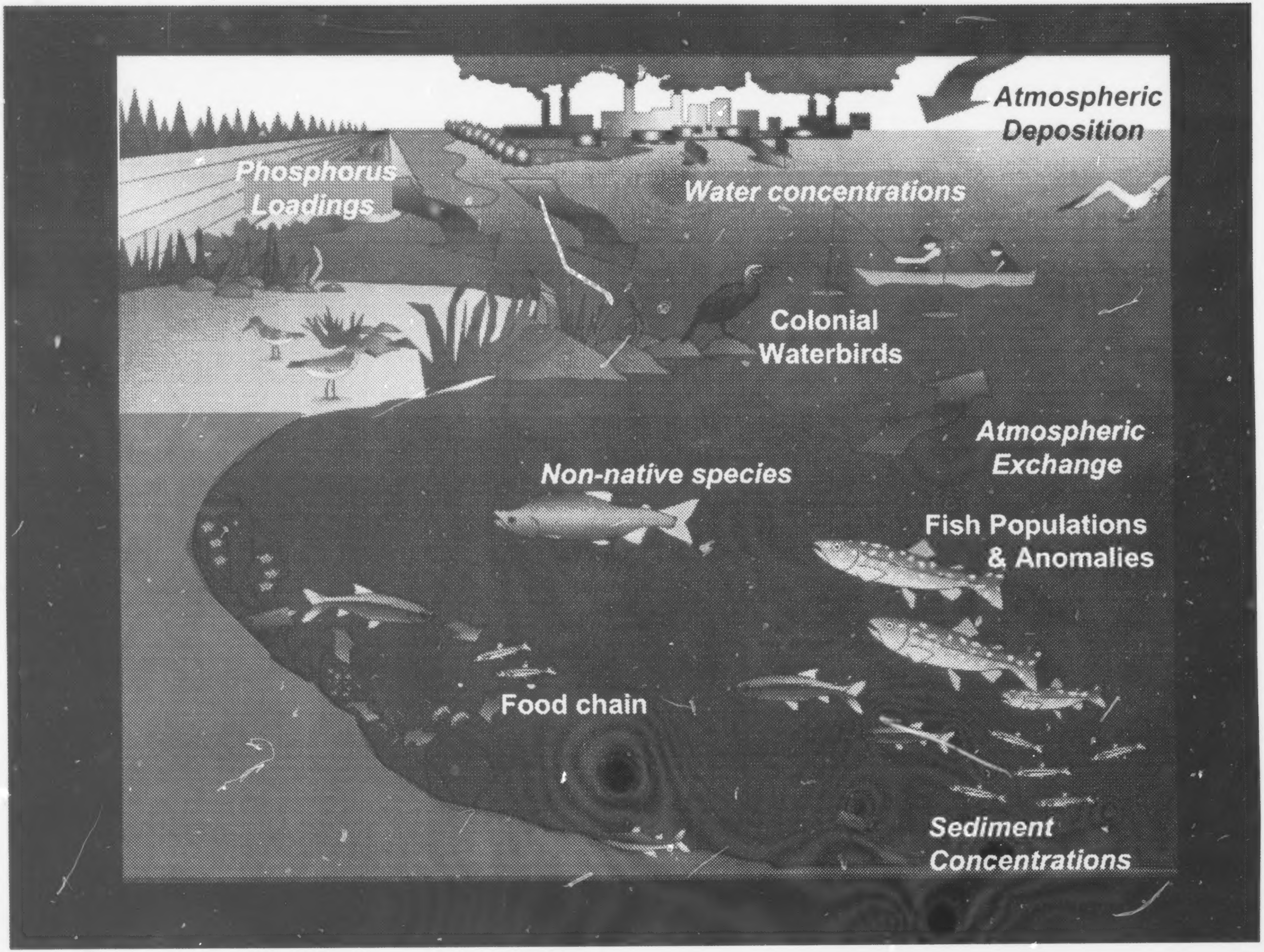
- Eight presentations based on indicator list
  - Water
  - Coastal wetlands
  - Land
  - Human Health
    - Beach closures
    - Drinking water
    - Fish consumption
  - Societal

Morning Details

- Index Development
- Summary and Charge

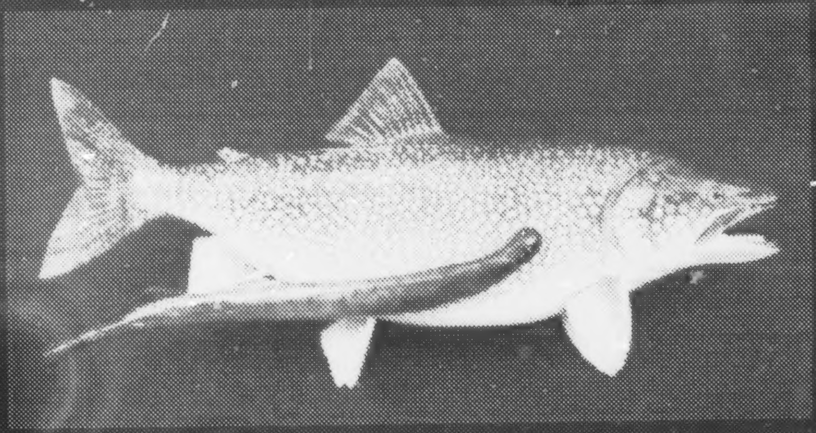
Nearshore and Open Water Indicators

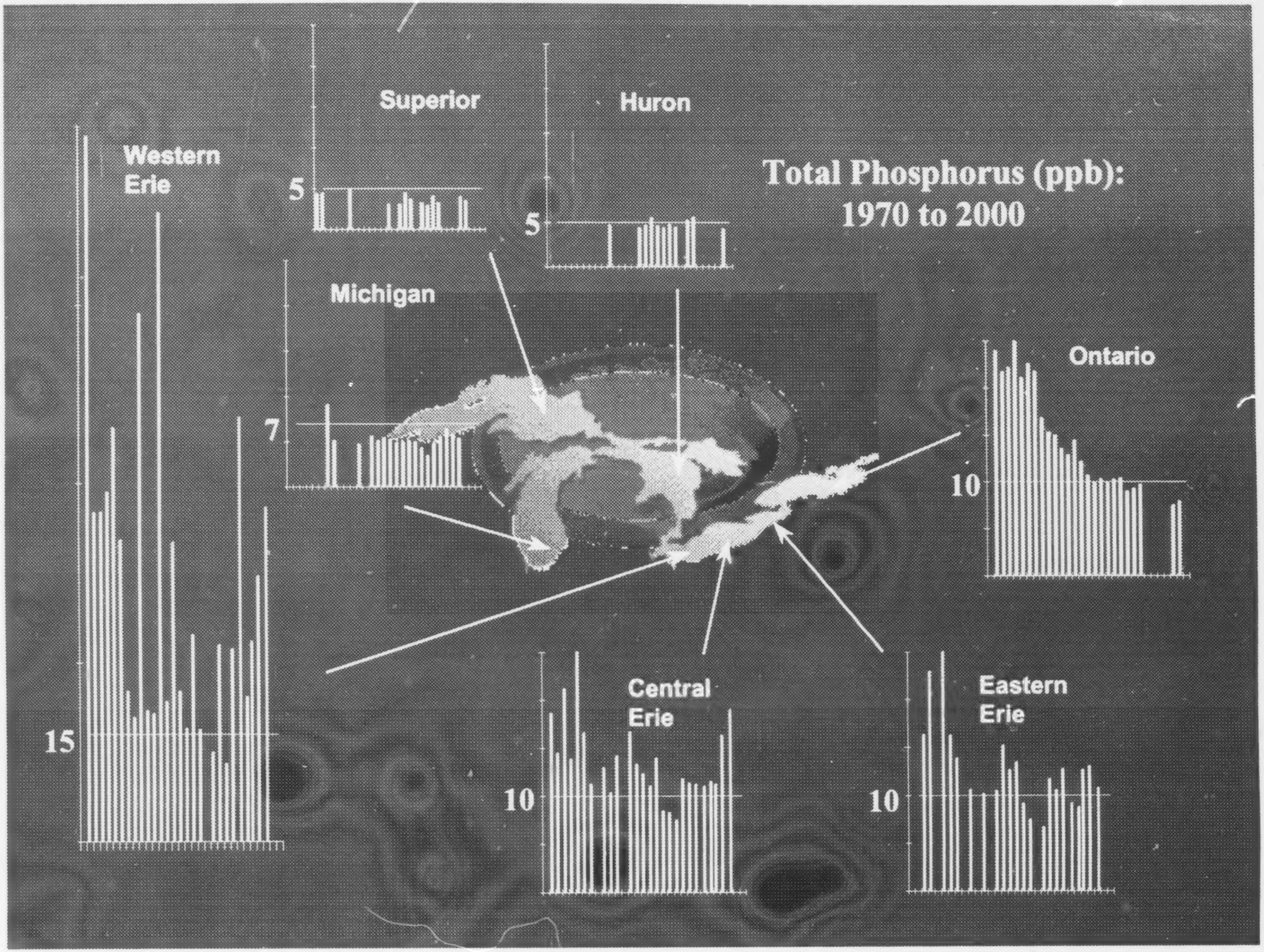
Melanie Neilson
Environment Canada


Atmospheric Deposition
Phosphorus Loadings
Water concentrations
Colonial Waterbirds
Atmospheric Exchange
Non-native species
Fish Populations & Anomalies
Food chain
Sediment Concentrations

"Water" Pressures

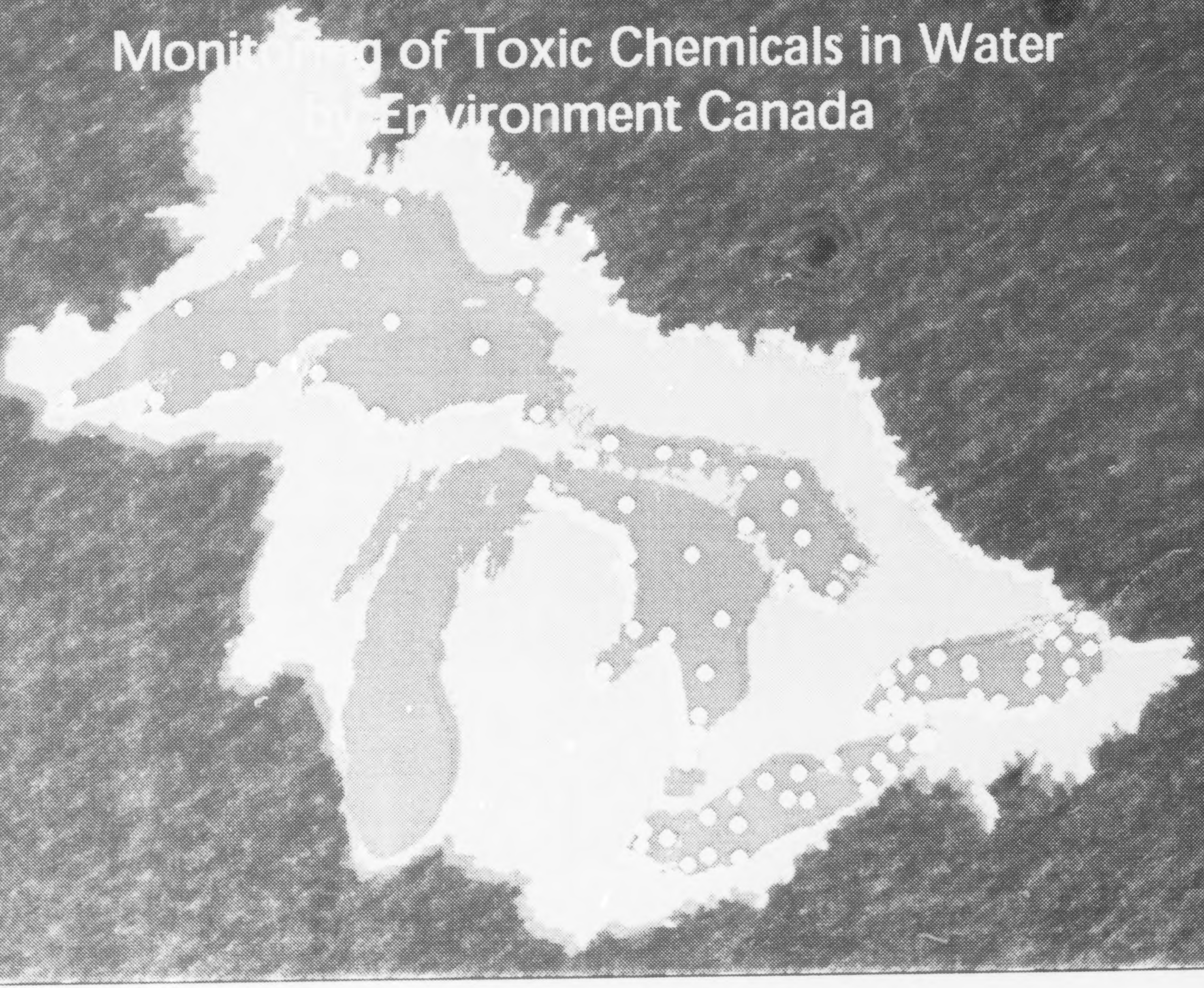
- Nutrients
- Toxic chemicals
- Non-native species



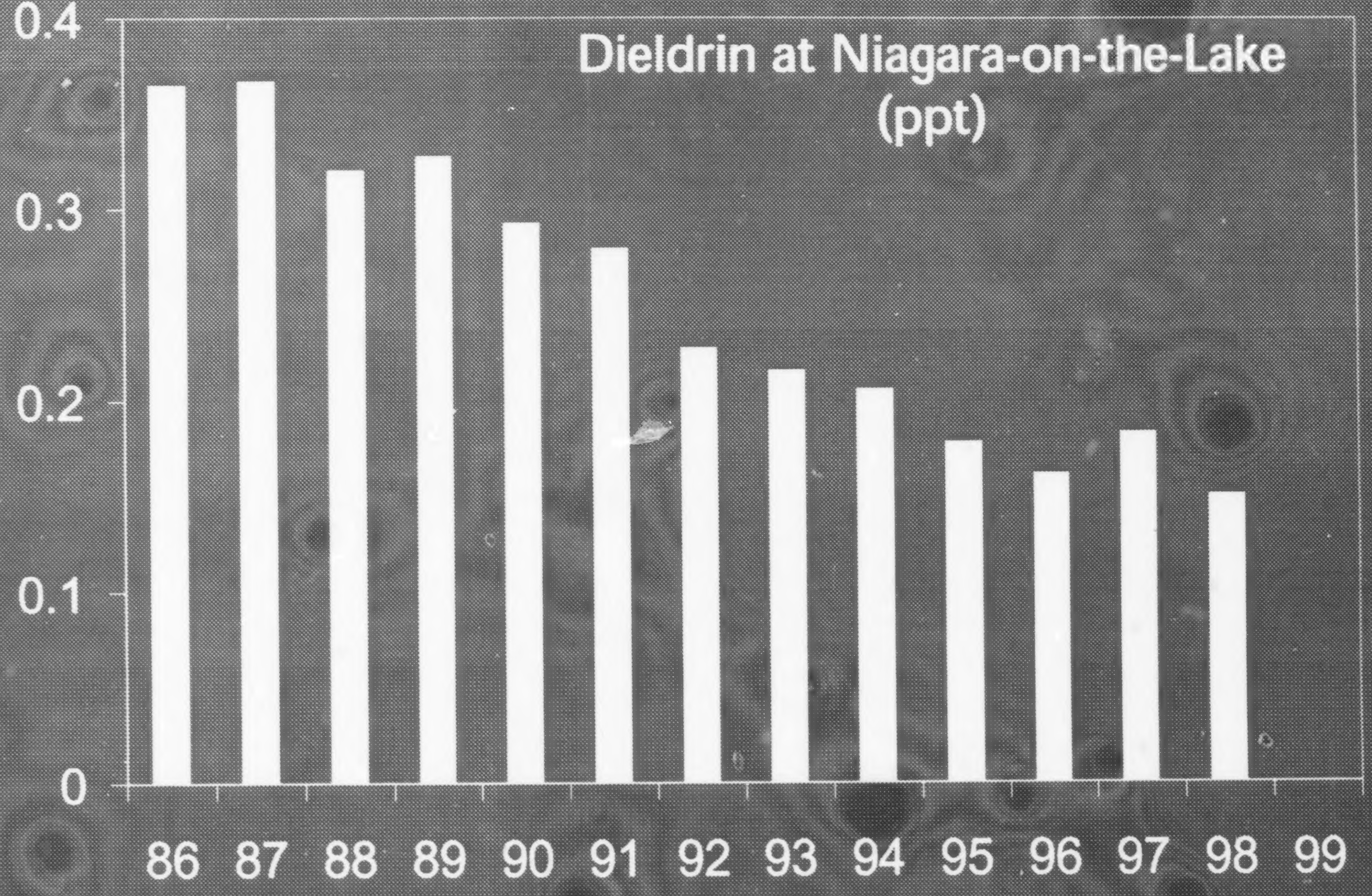


Total Phosphorus (ppb):
1970 to 2000

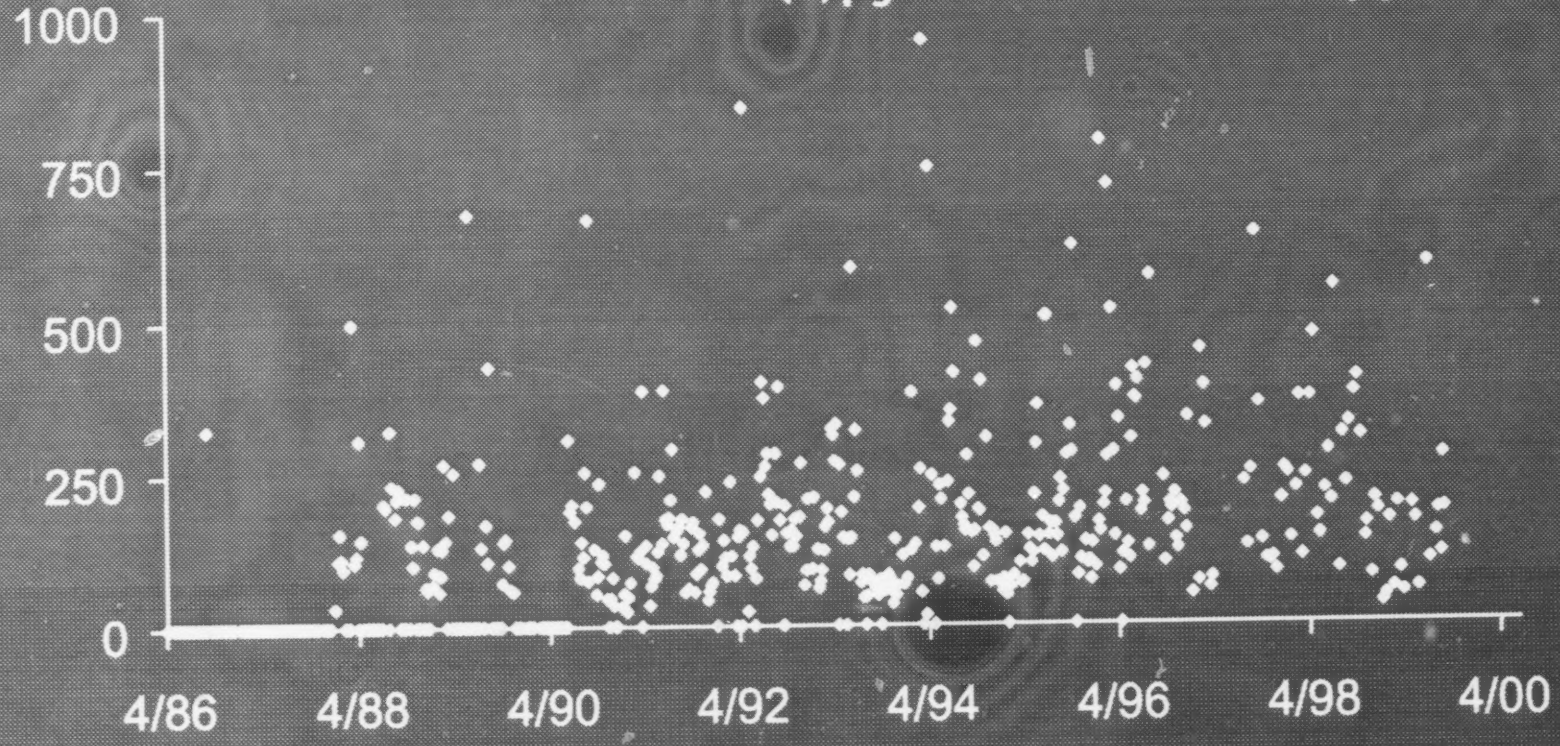
Monitoring of Toxic Chemicals in Water by Environment Canada



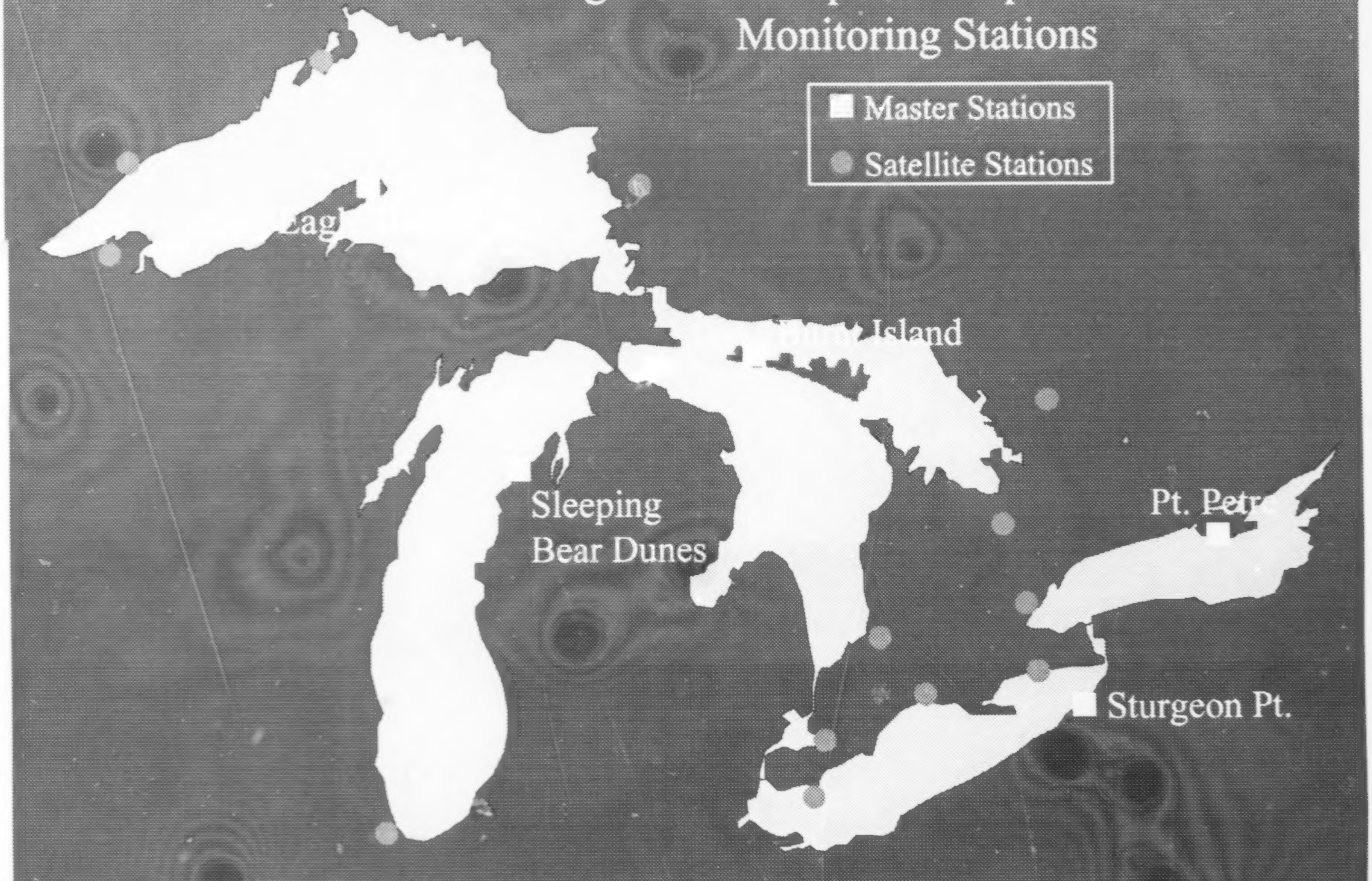
Toxic Chemicals: Water



Toxic Chemicals: Water

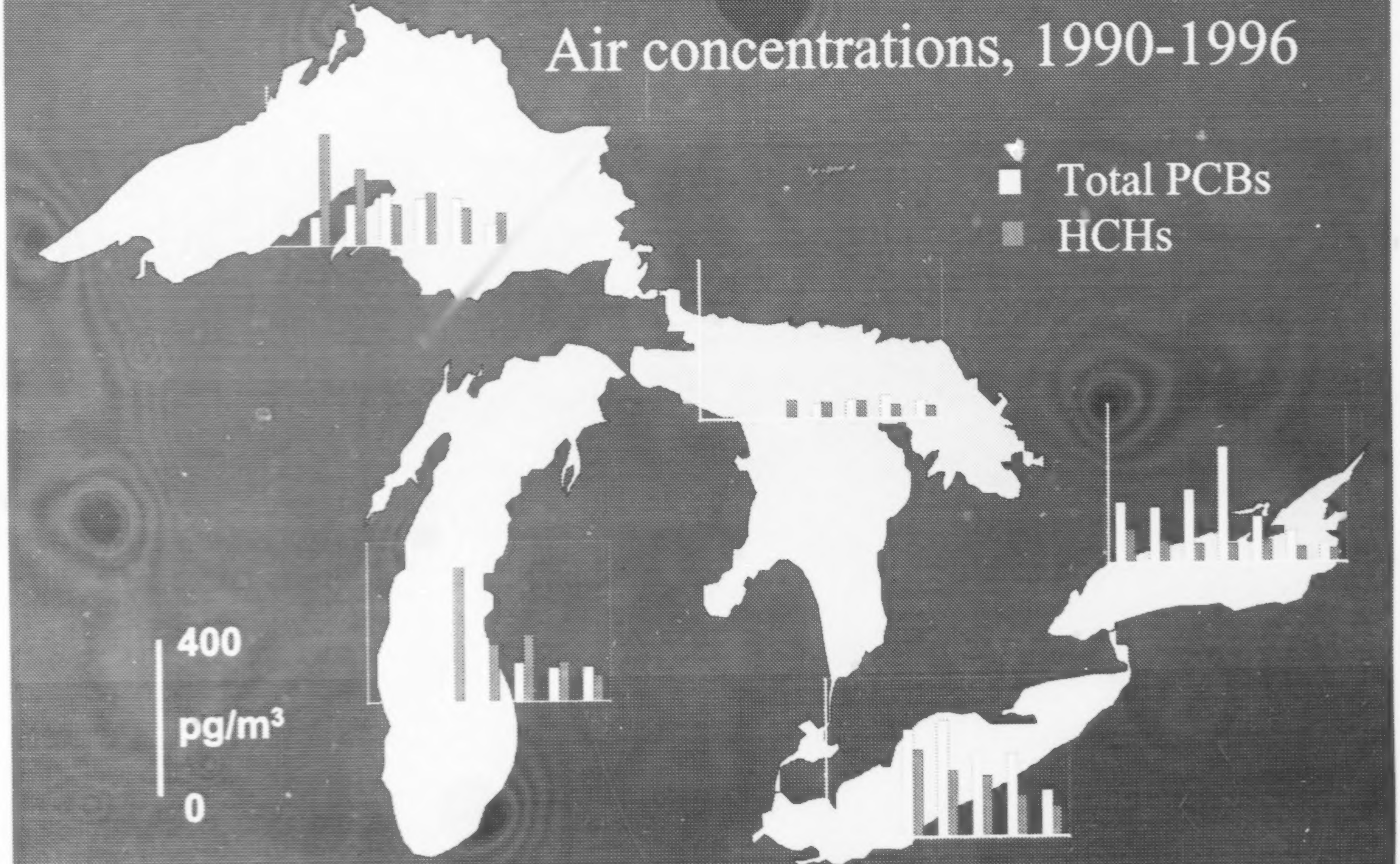

Benzo(a)pyrene at Fort Erie (ppt)

Integrated Atmospheric Deposition Network Monitoring Stations



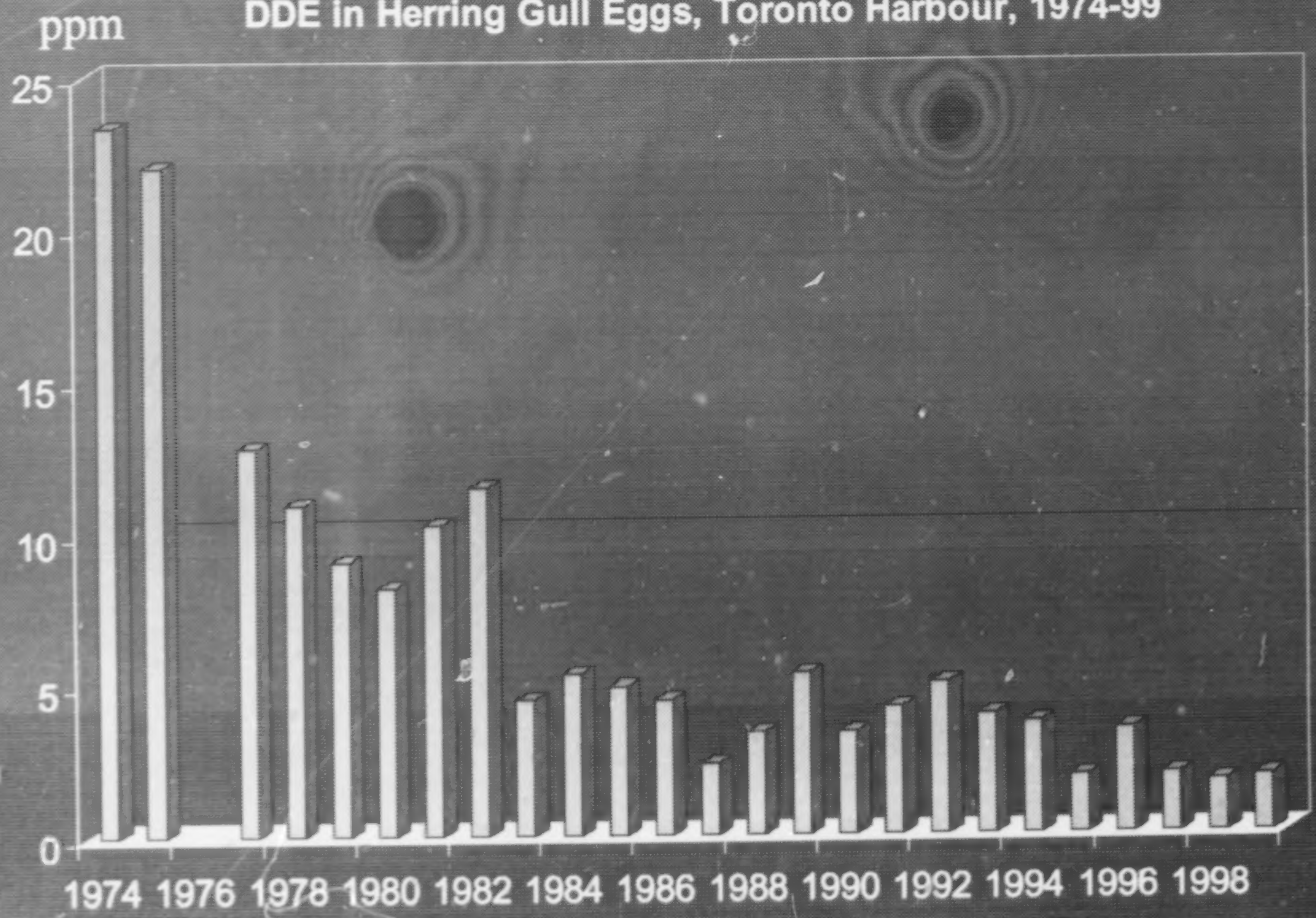
■ Master Stations
● Satellite Stations
Eag
Island
Sleeping Bear Dunes
Pt. Petre
Sturgeon Pt.

Toxic chemicals:
Air concentrations, 1990-1996

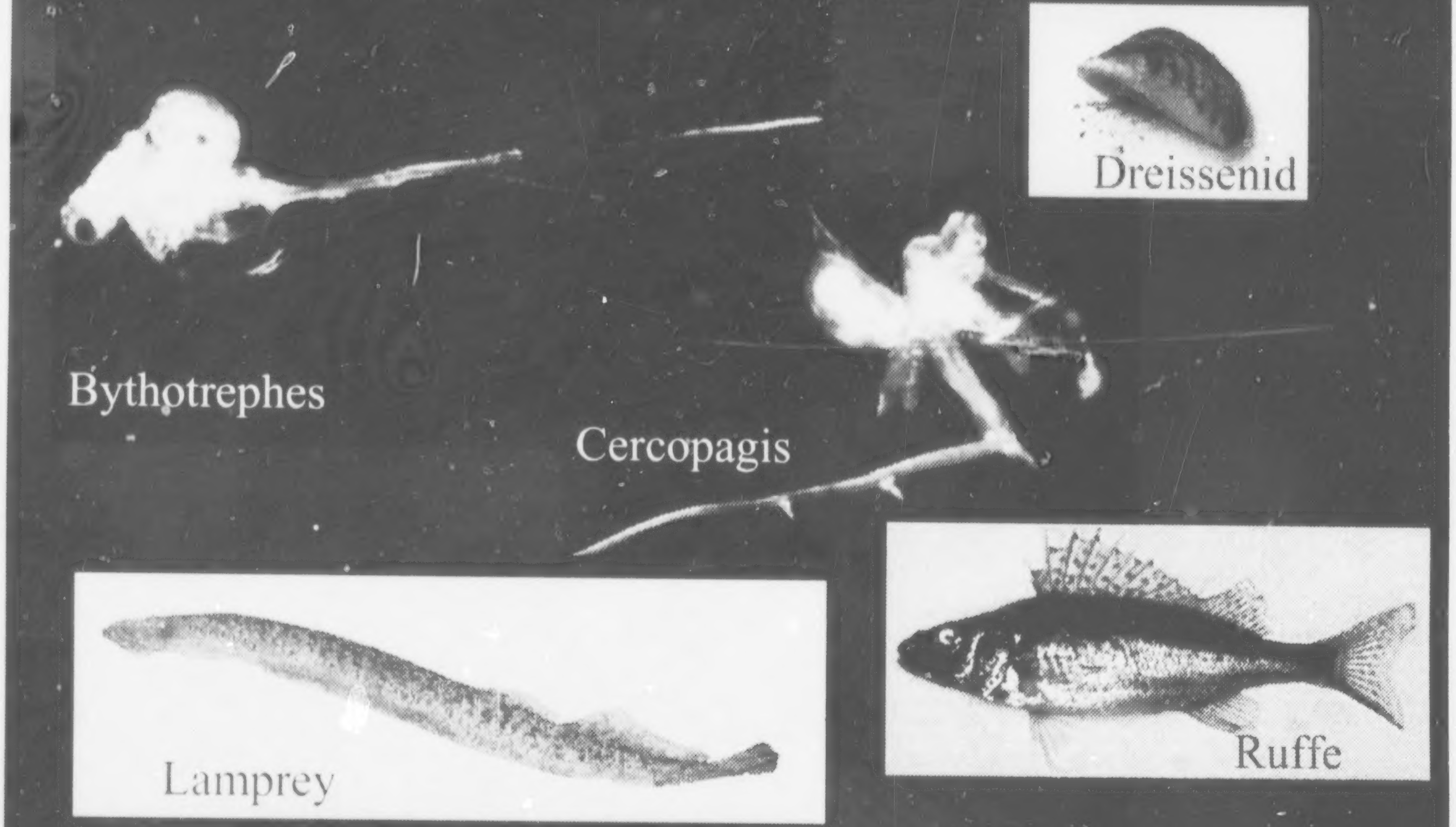

Total PCBs
HCHs
400
pg/m^3
0

Toxic Chemicals: Colonial Waterbirds

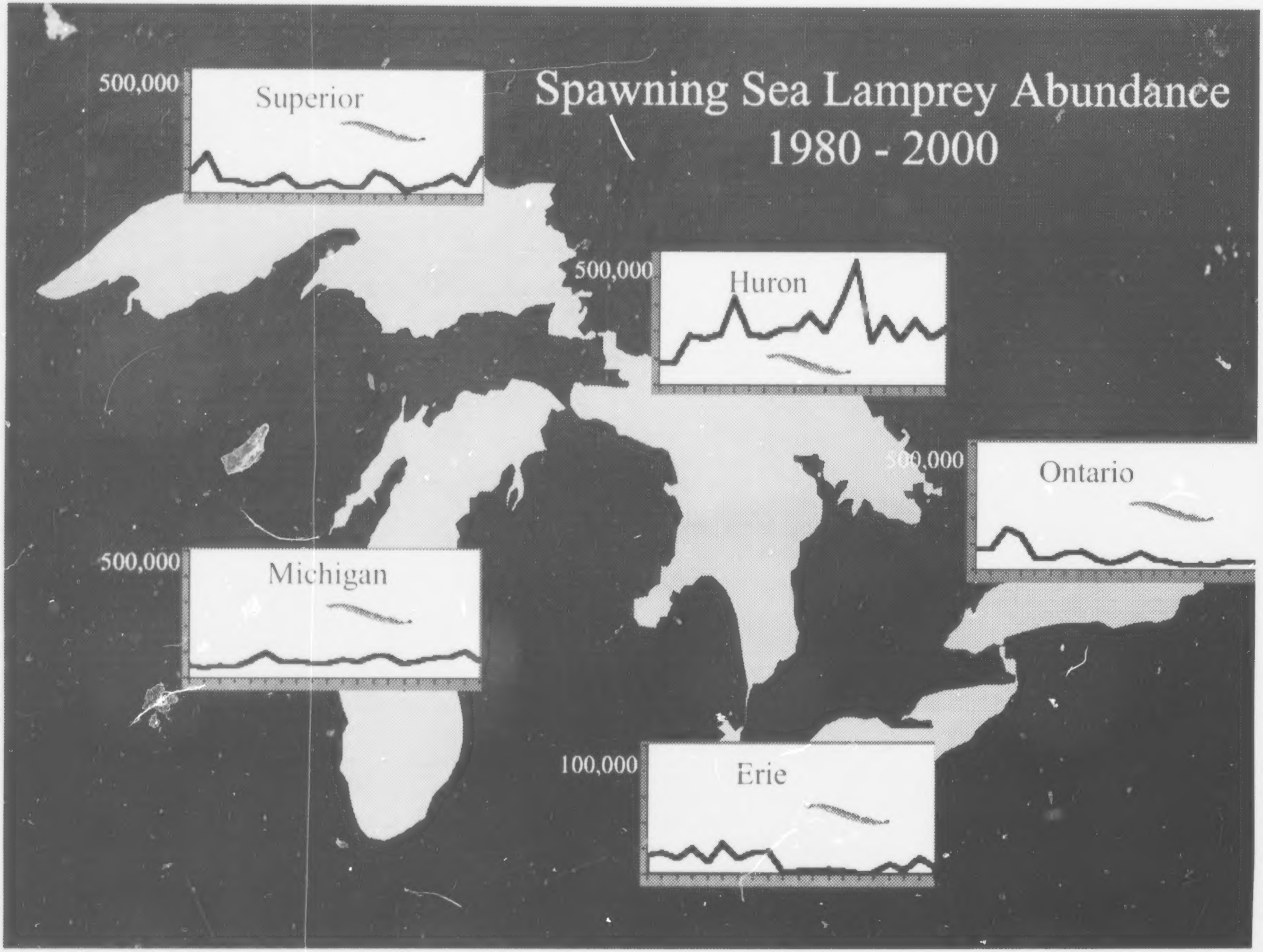
DDE in Herring Gull Eggs, Toronto Harbour, 1974-99



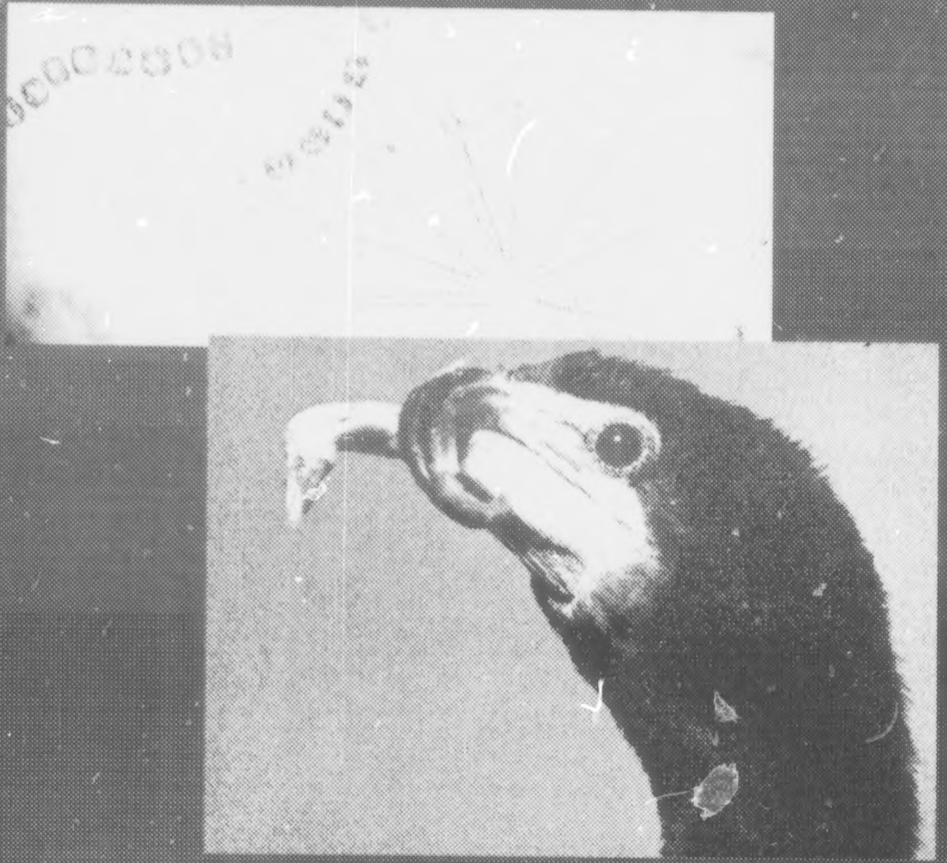
Non-native species


Dreissenid
Bythotrephes
Cercopagis
Lamprey
Ruffe

Spawning Sea Lamprey Abundance
1980 - 2000

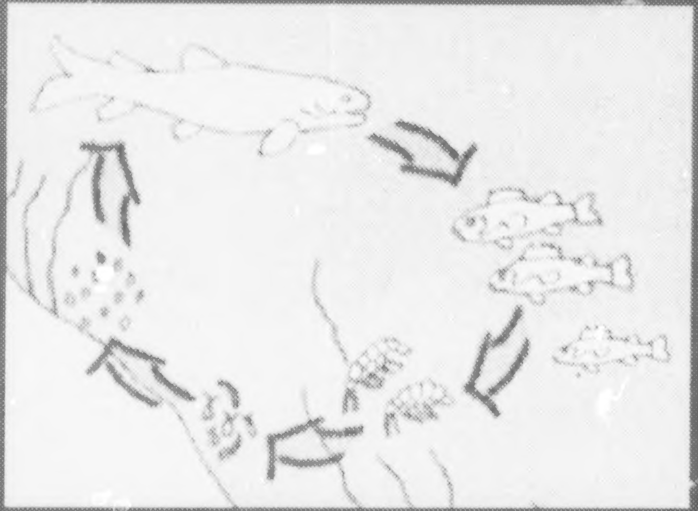


"Water" State

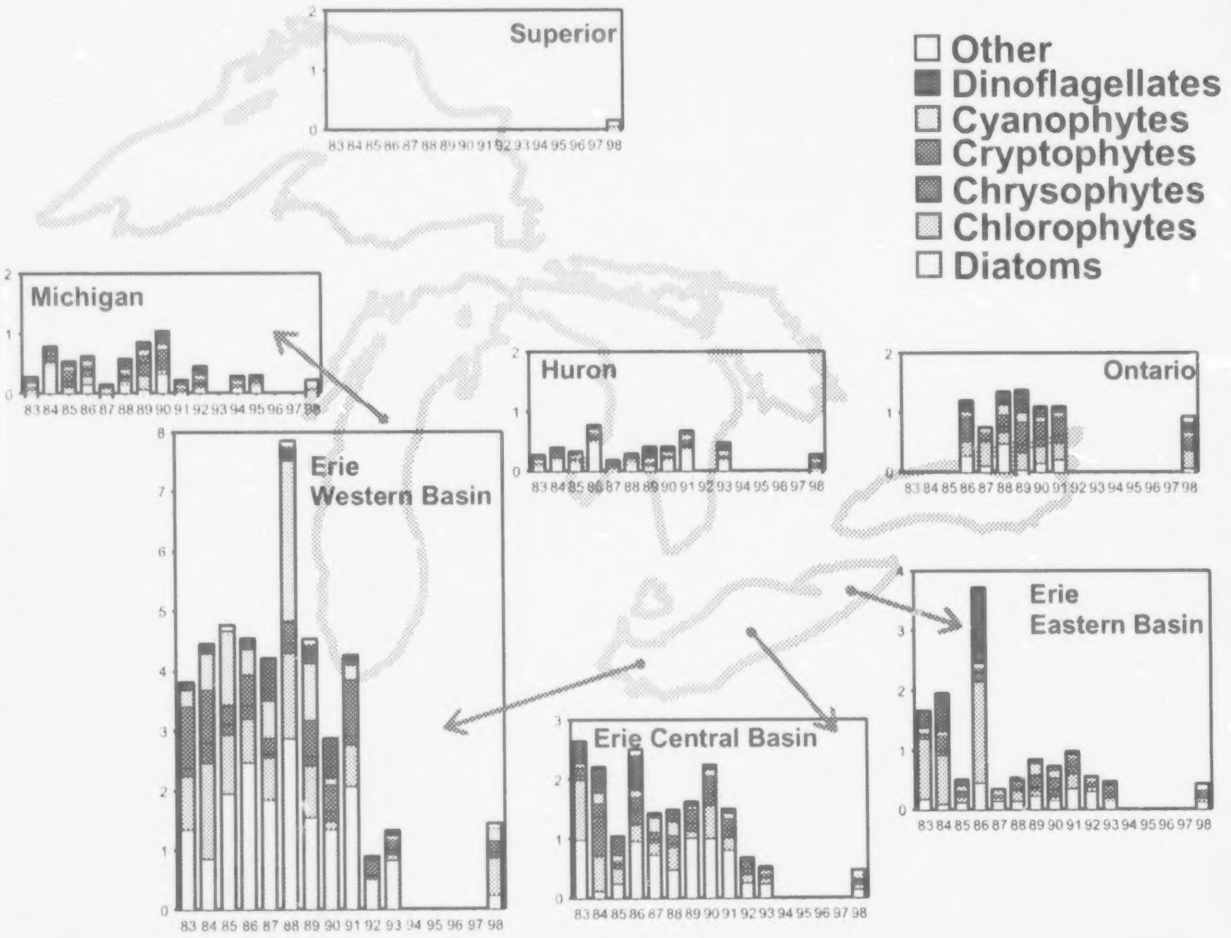


- Population diversity
- Abundance
- Absence of deformities

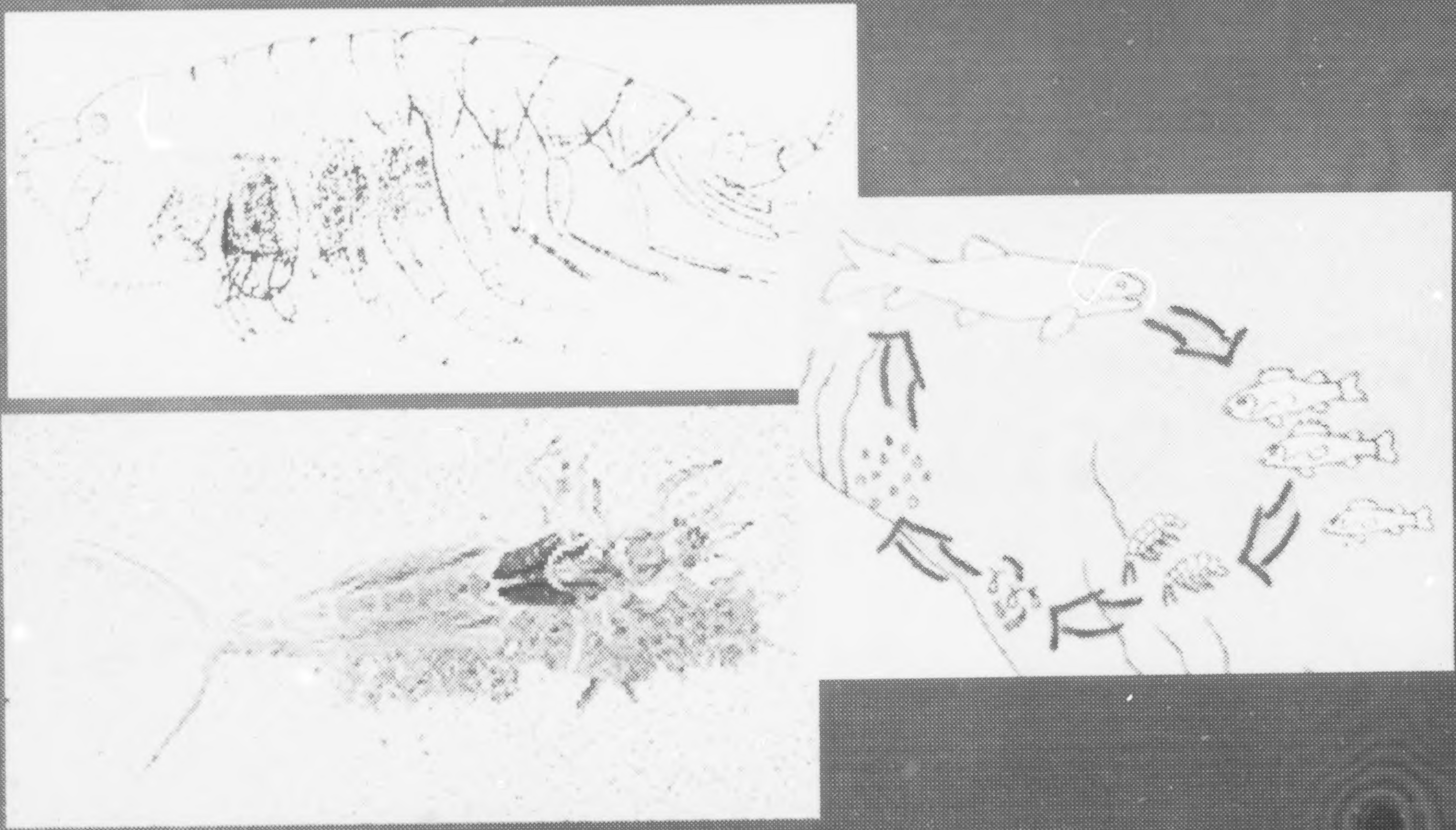
Phytoplankton & Zooplankton

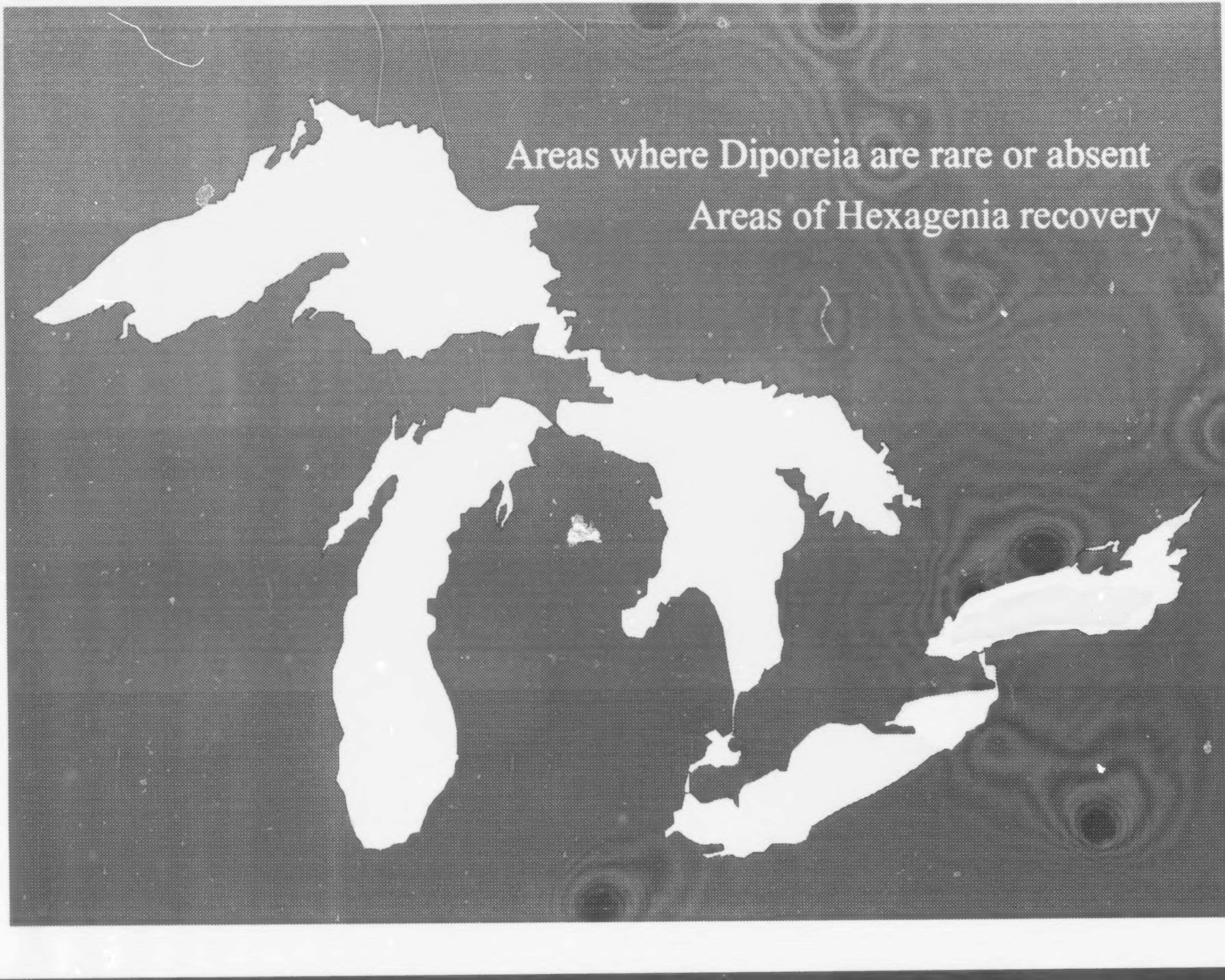


Phytoplankton Biovolume (g/m³) and Composition, 1983-1998

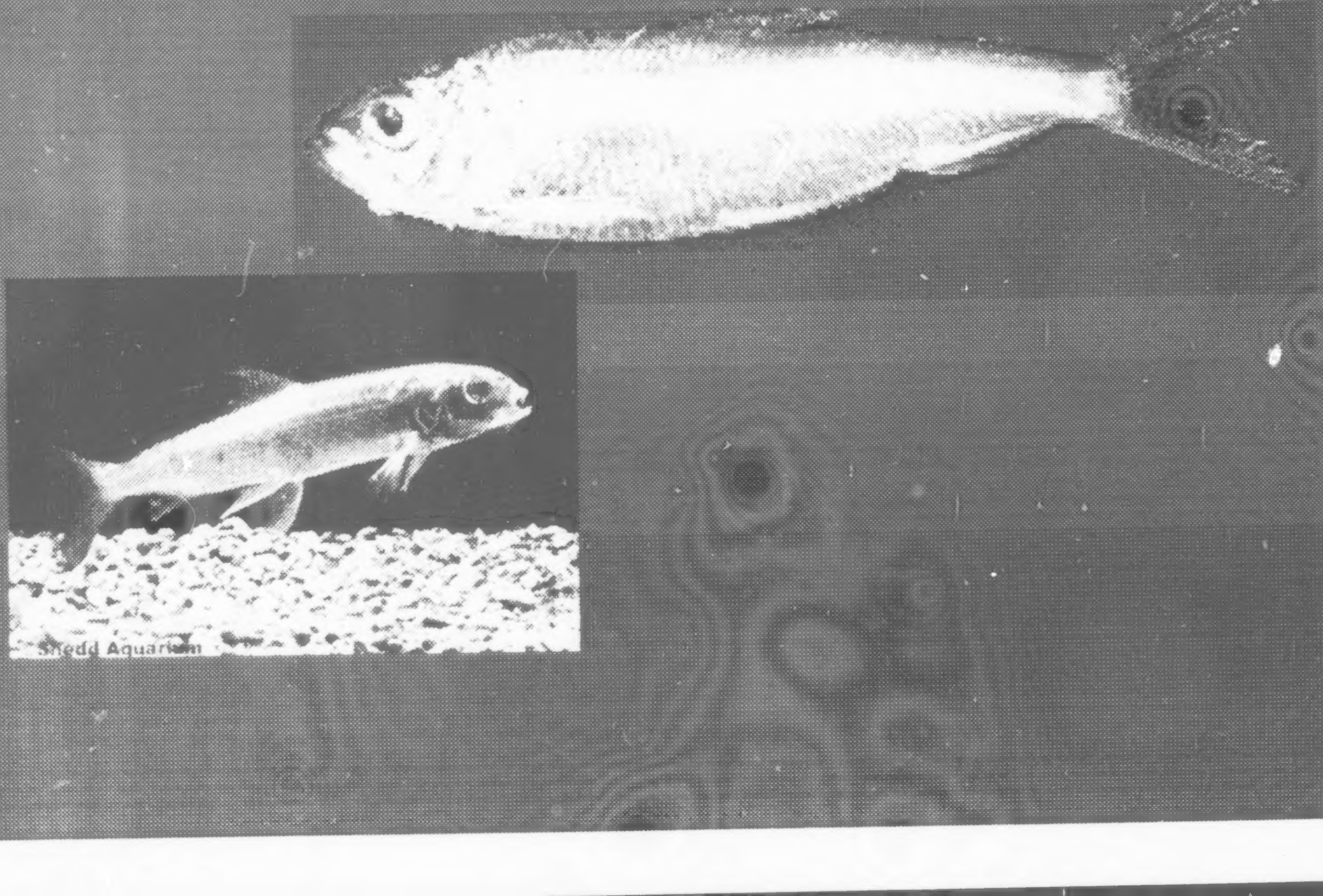


Benthos: Diporeia & Hexagenia

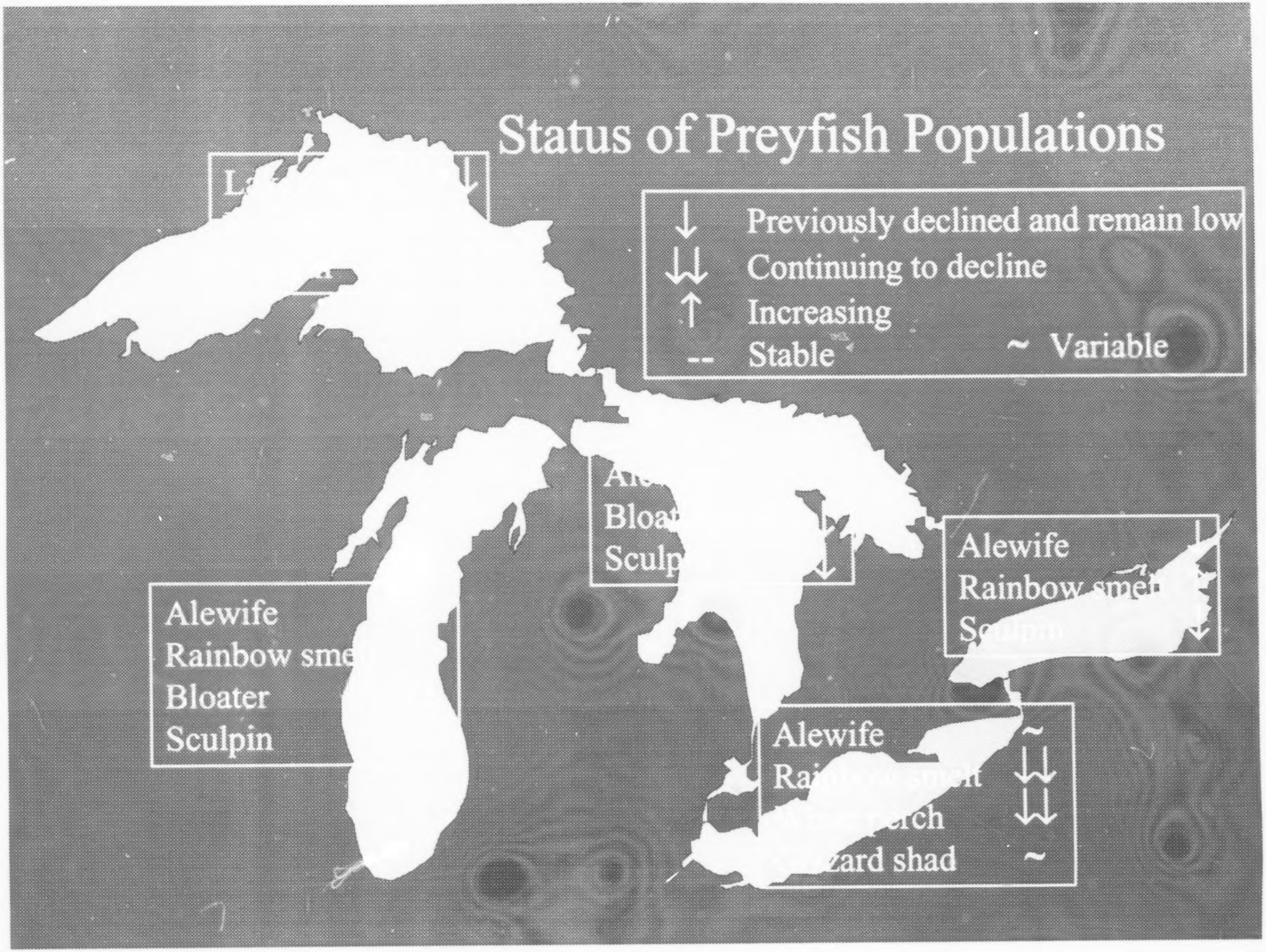



Areas where Diporeia are rare or absent
Areas of Hexagenia recovery

Preyfish populations



Shedd Aquarium



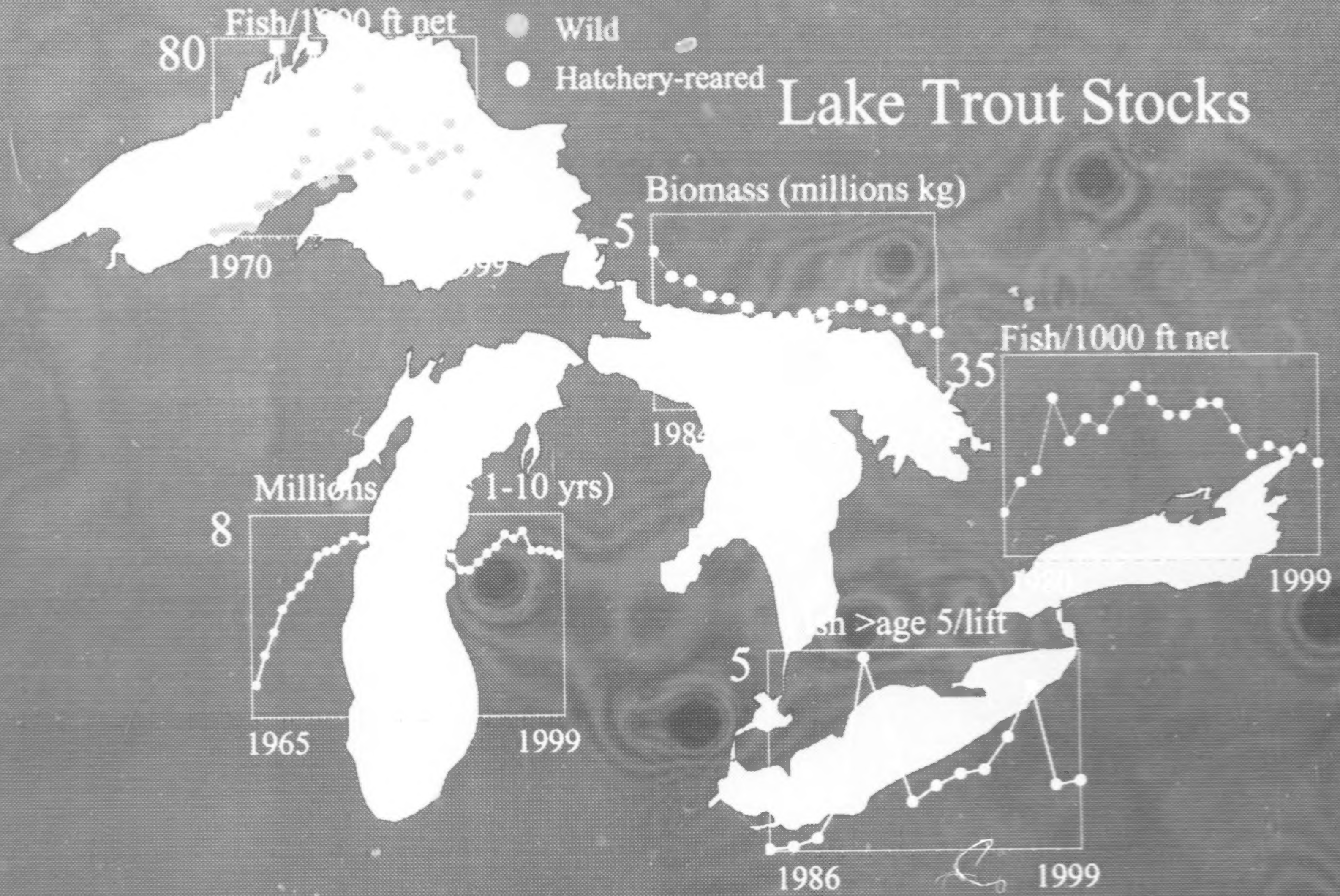
Status of Preyfish Populations

↓ Previously declined and remain low
↓↓ Continuing to decline
↑ Increasing
-- Stable
~ Variable

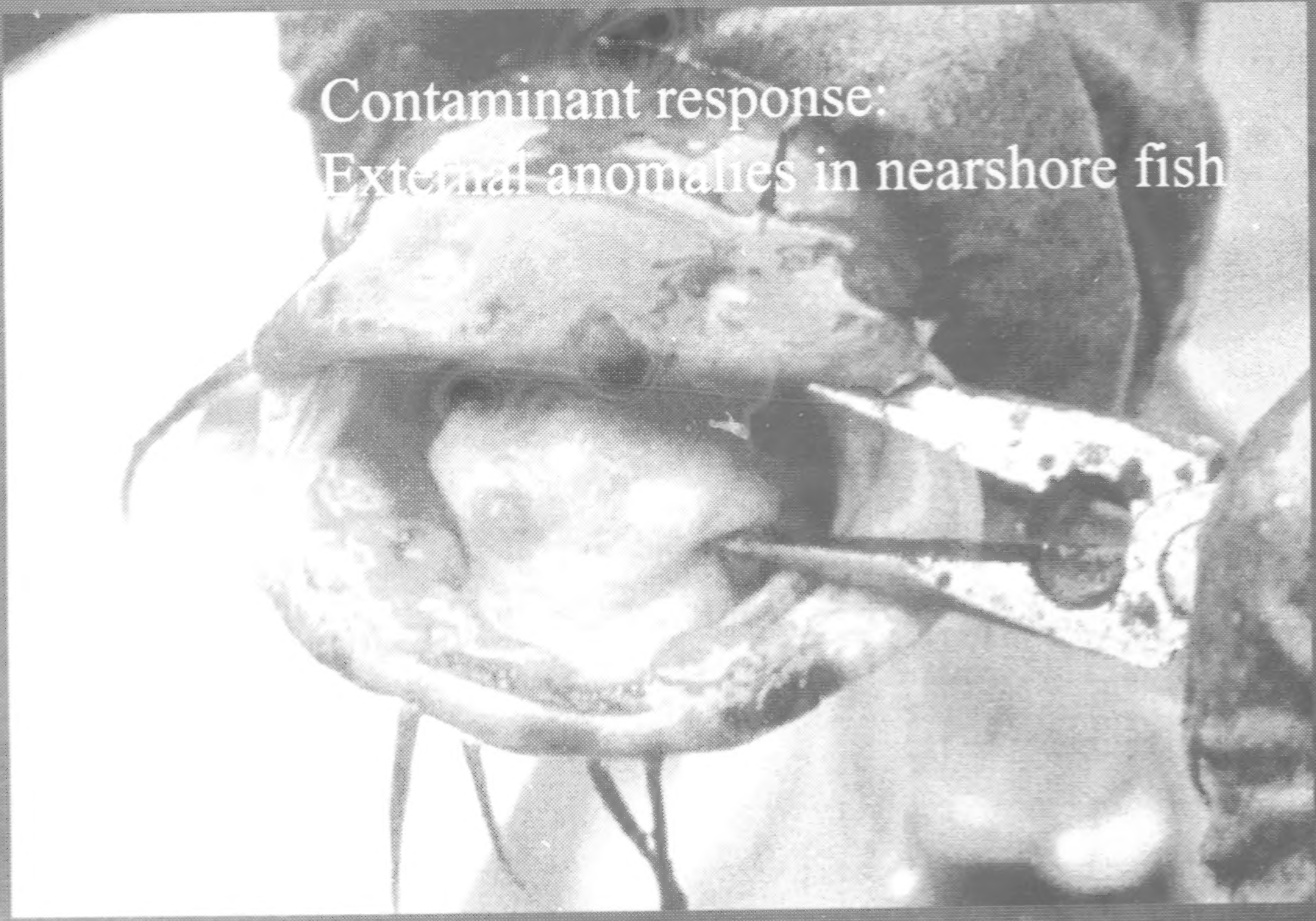
L
↓
Ale
Bloat
Sculp
↓
Alewife
Rainbow sme
Bloater
Sculpin
Alewife ↓
Rainbow smelt ↓
Sculpin ↓
Alewife ~
Rainbow smelt ↓↓
perch ↓↓
zard shad ~

Predator Populations: Lake Trout

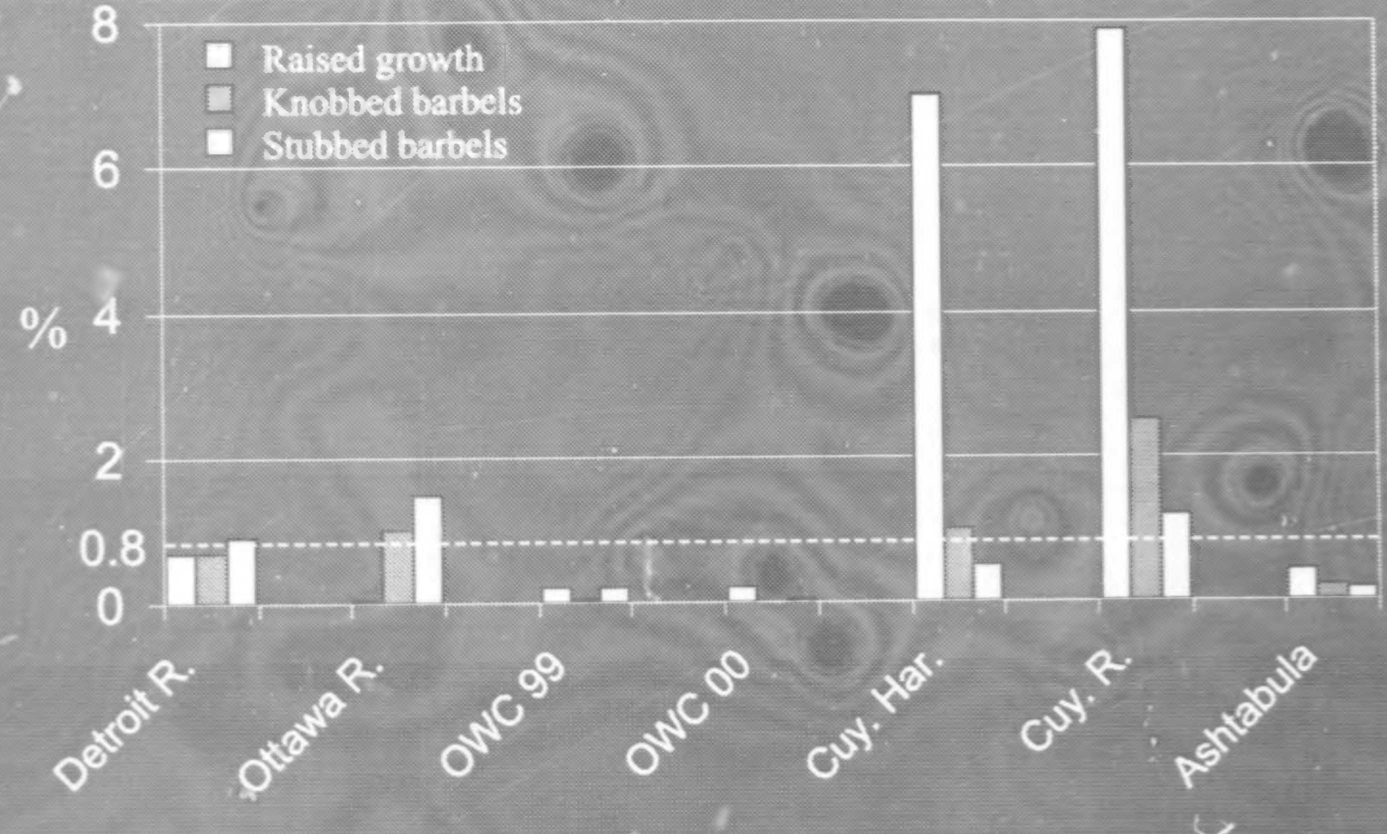
Lake Trout Stocks



Contaminant response:
External anomalies in nearshore fish



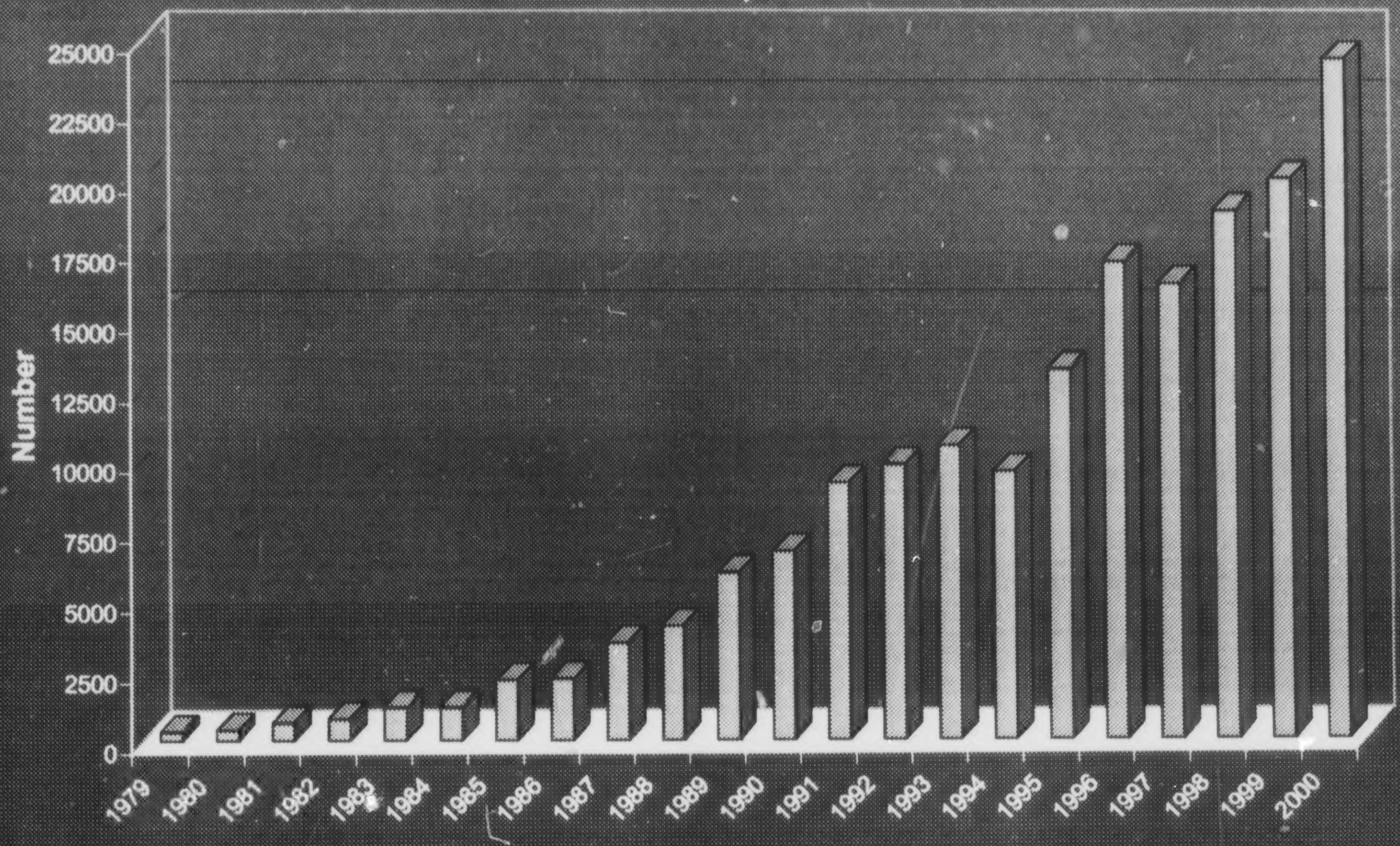
Frequency of External Lesions for Brown Bullheads
Lake Erie, 1999 - 2000



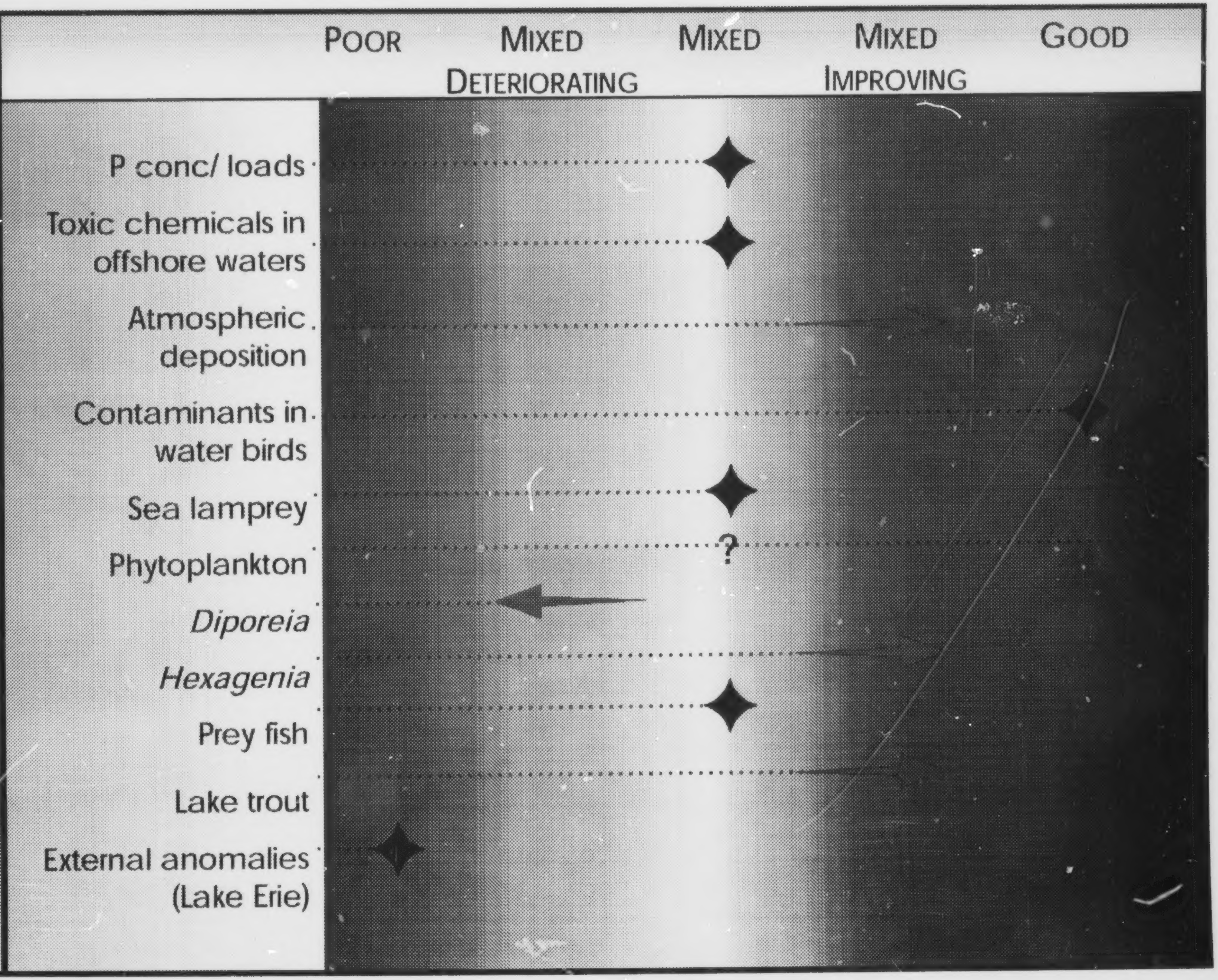
Contaminant Response: Waterbirds

- Populations of most species increased
- Gross effects appear to have subsided
- Many subtle effects surfacing

Double-crested Cormorant nests (breeding pairs) in Lake Ontario, 1979-2000



OPEN AND NEARSHORE WATERS



Acknowledgements

Indicator	Principal Authors
Phosphorus concentrations	*Scott Painter, Environment Canada & Paul Bertram, USEPA*
Toxic chemicals in offshore waters	*Scott Painter, Environment Canada*
Atmospheric deposition of toxic chemicals	*Ron Hites & Ilora Basu, Indiana University*
Contaminants in colonial waterbirds	*Chip Weseloh, Environment Canada*
Sea lamprey abundance	*Gavin Christie, GLFC*

Acknowledgements (cont'd)

Indicator	Principal Authors
Phytoplankton & Zooplankton	*Rick Barbiero, DynCorp I&ET and Marc Tuchman, USEPA*
Diporeia	*Tom Nalepa, NOAA*
Hexagenia	*Tom Edsall, USGS*
Preyfish	*Guy Fleischer, USGS*
Lake Trout	*Charles Bronte, U.S. Fish & Wildlife Service*
External anolmalies	*Steve Smith, USGS & Paul Baumann, USGS*

Land Indicators: Assessing the Effects Of Land Use on The Great Lakes Basin Ecosystem

Victoria Pebbles

Great Lakes Commission

Ecosystem Objectives

- Remove threats of contamination
  - Reduce persistent toxic substances and other Pollutants
- Non-degradation of soils, plants, water and air
- Biological community integrity and diversity

Ecosystem Objectives
(continued)

- Protection of rare and endangered species
- Healthy aquatic and terrestrial plant and animal life
- Sustainable development

SOLEC '96 Findings

- Current land use is inefficient
- Land use has been destructive
- The health of the land by the lakes is degrading
- Planning and incentives are the keys to sustainability

State of the Ecosystem:
Land Indicators

- Urban density
- Mass transportation
- Brownfields redevelopment
- Sustainable agriculture

Land Indicators

(continued)

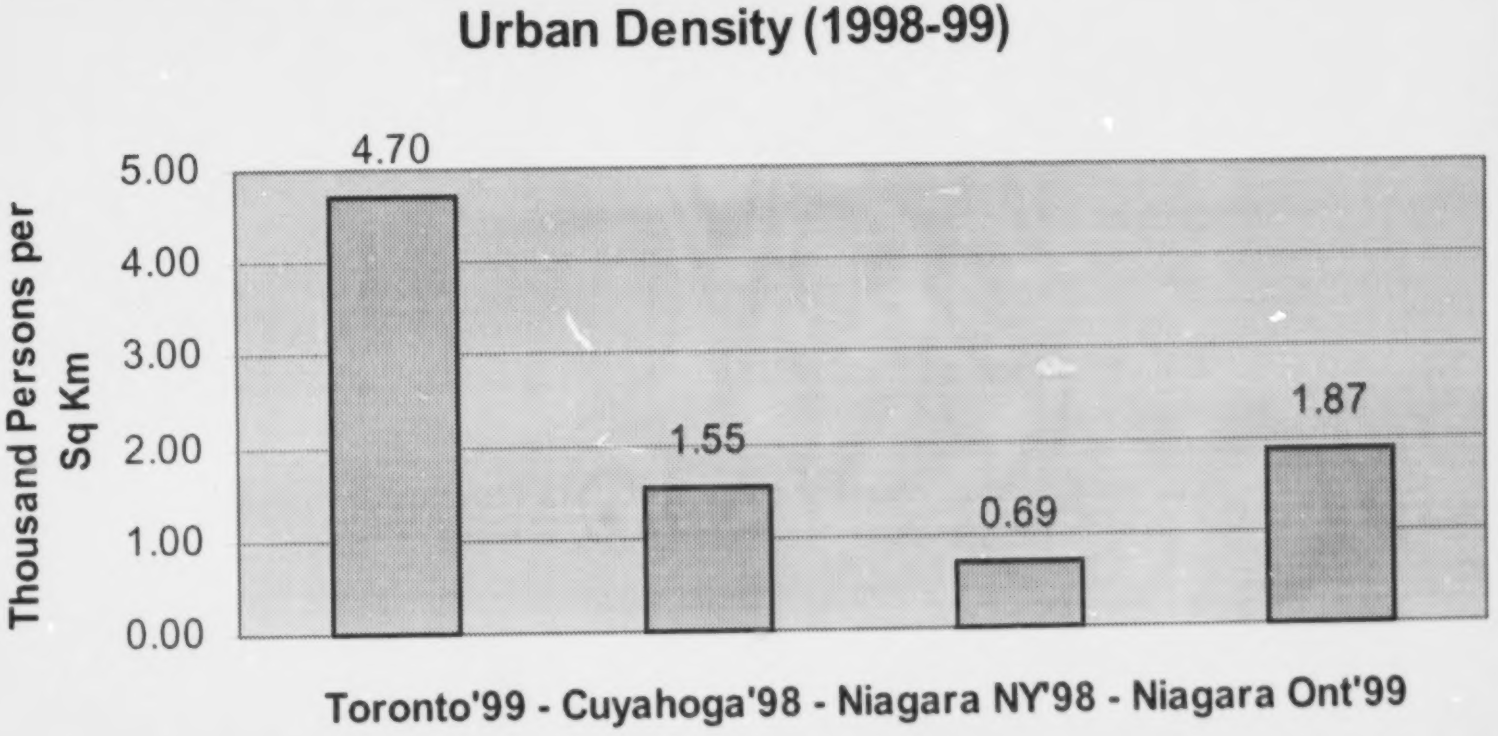
- Extent of hardened shoreline
- Area, quality & protection of alvar communities
- Contaminants affecting the productivity of bald eagles

SOLEC 2000 Findings

New and ongoing policies and
programs are needed to mitigate
the negative impacts of land use
even as we gather more data

Urban Density

- Marked difference among Basin communities



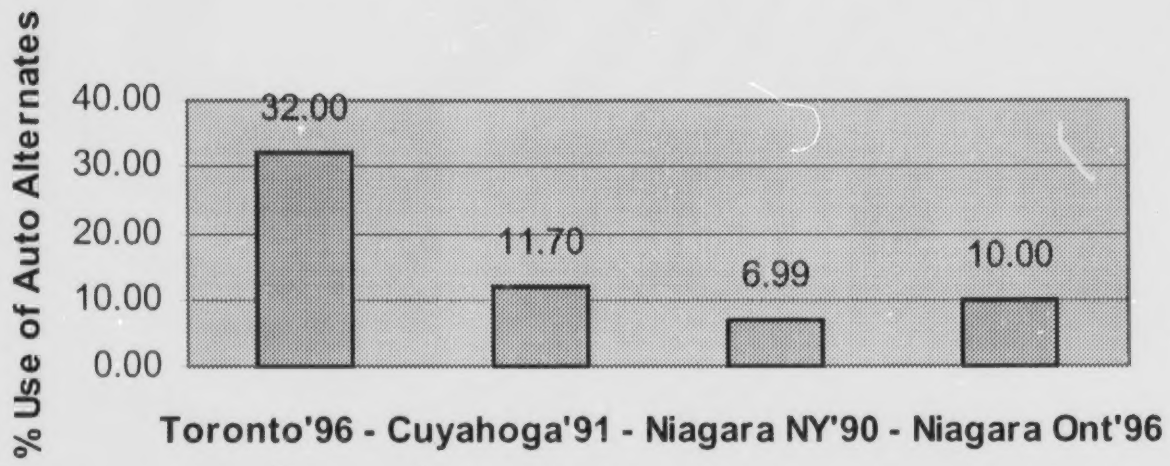
Urban Density

- Varies depending on community size, age and type of planning
- Direct relationship to
  - Population density
  - Redevelopment
  - Mass transit
- **State: inadequate data (deteriorating)**

Urban Density Conclusions

- Higher densities appear to be a more efficient urban land use
- Policies are needed to promote greater urban densities

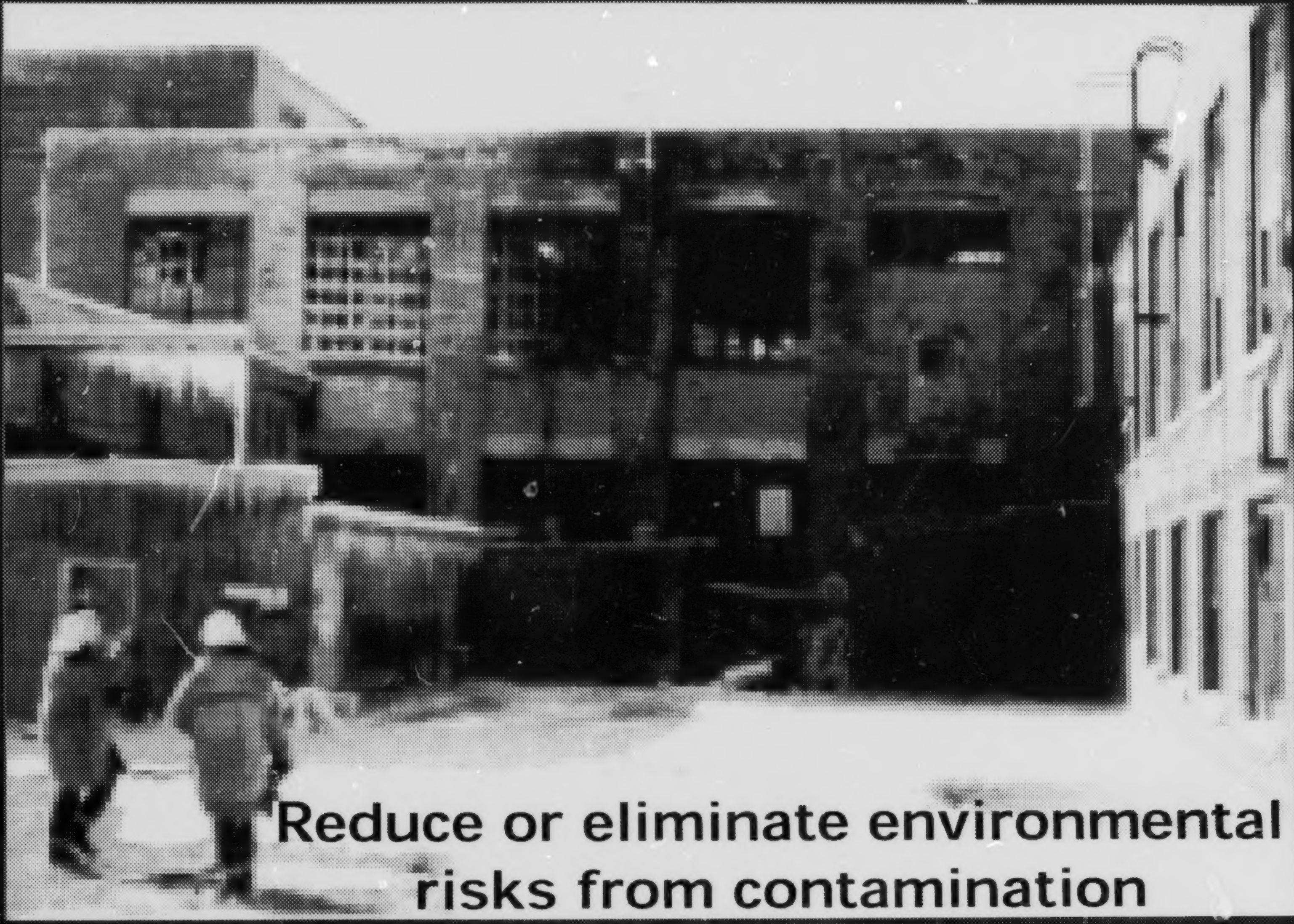
Commuters Using Alternate to Auto Transportation (1990-1996)



Mass Transportation

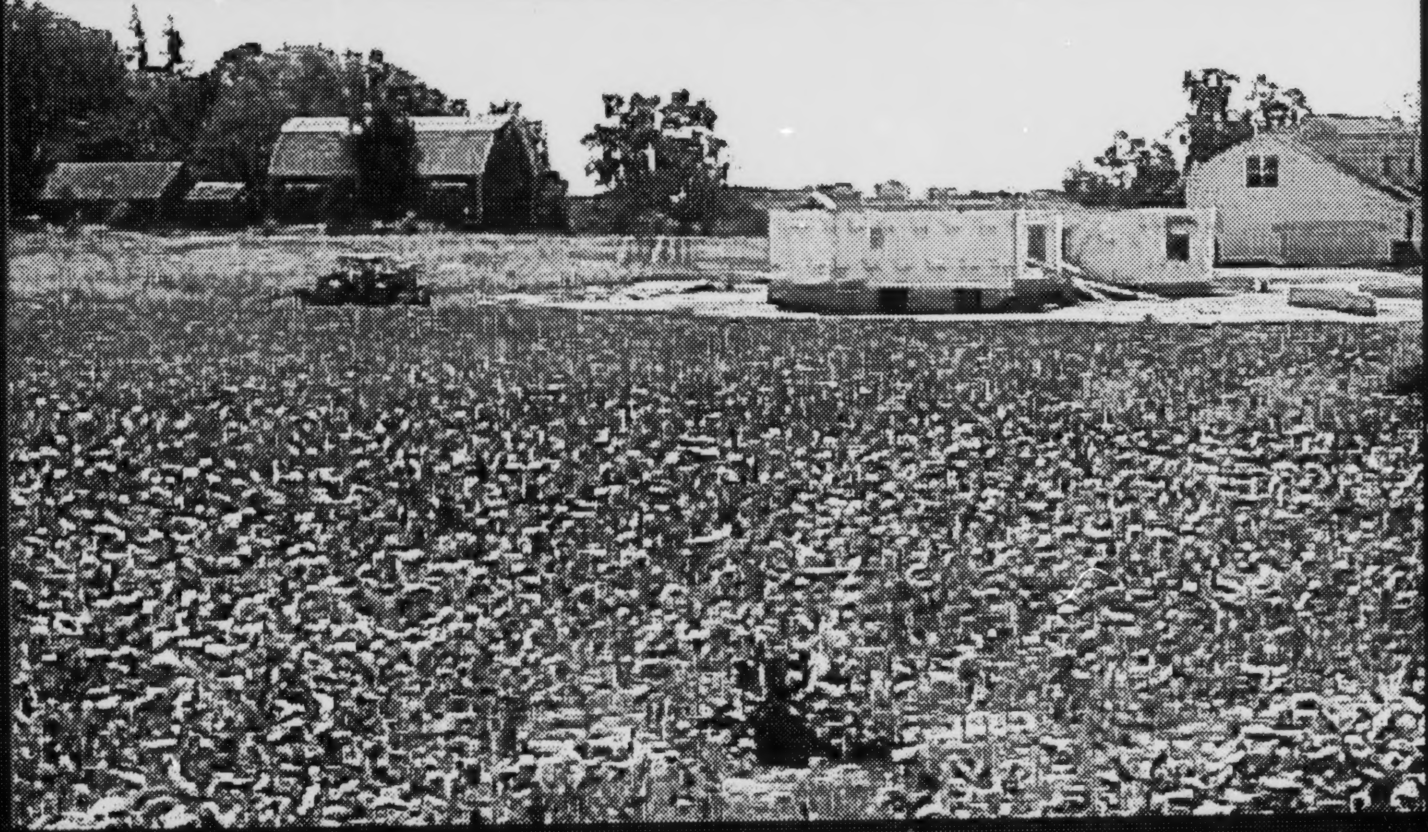
- Increased mass transportation depends on:
  - Urban density
  - Population density
  - Cost-effective transit
- Need better understanding of relationships among the three
- **State: inadequate data**

Brownfields Redevelopment



Reduce or eliminate environmental
risks from contamination

Brownfields Redevelopment



Reduce pressure for open space conversion

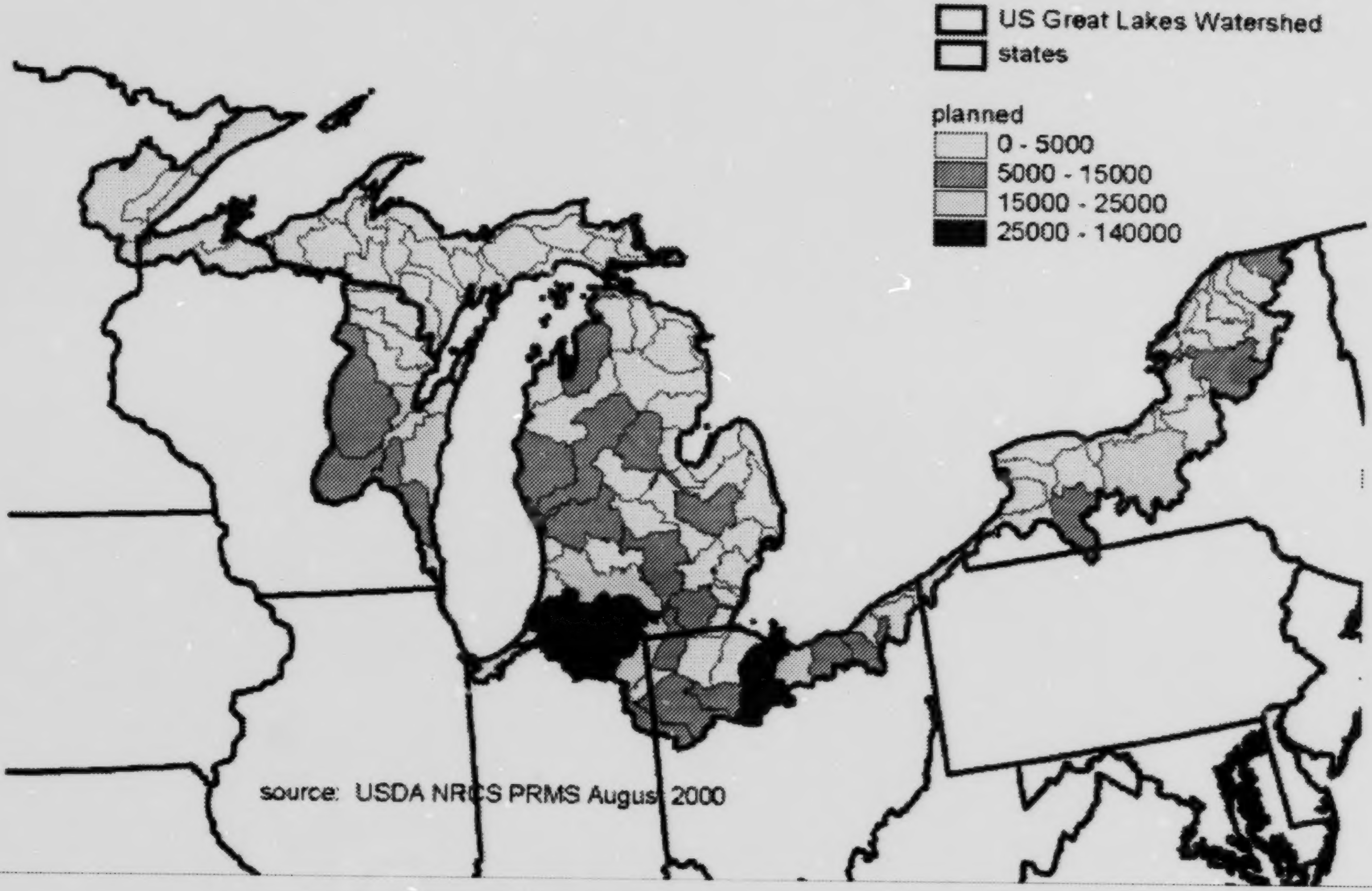
Brownfields Redevelopment

- Cleanup *and* redevelopment has risen dramatically since the mid-1990's
- **State: good**
- Offset by incentives for greenfield development
- More reliable tracking needed; requires state/local coordination

Sustainable Agricultural Practices

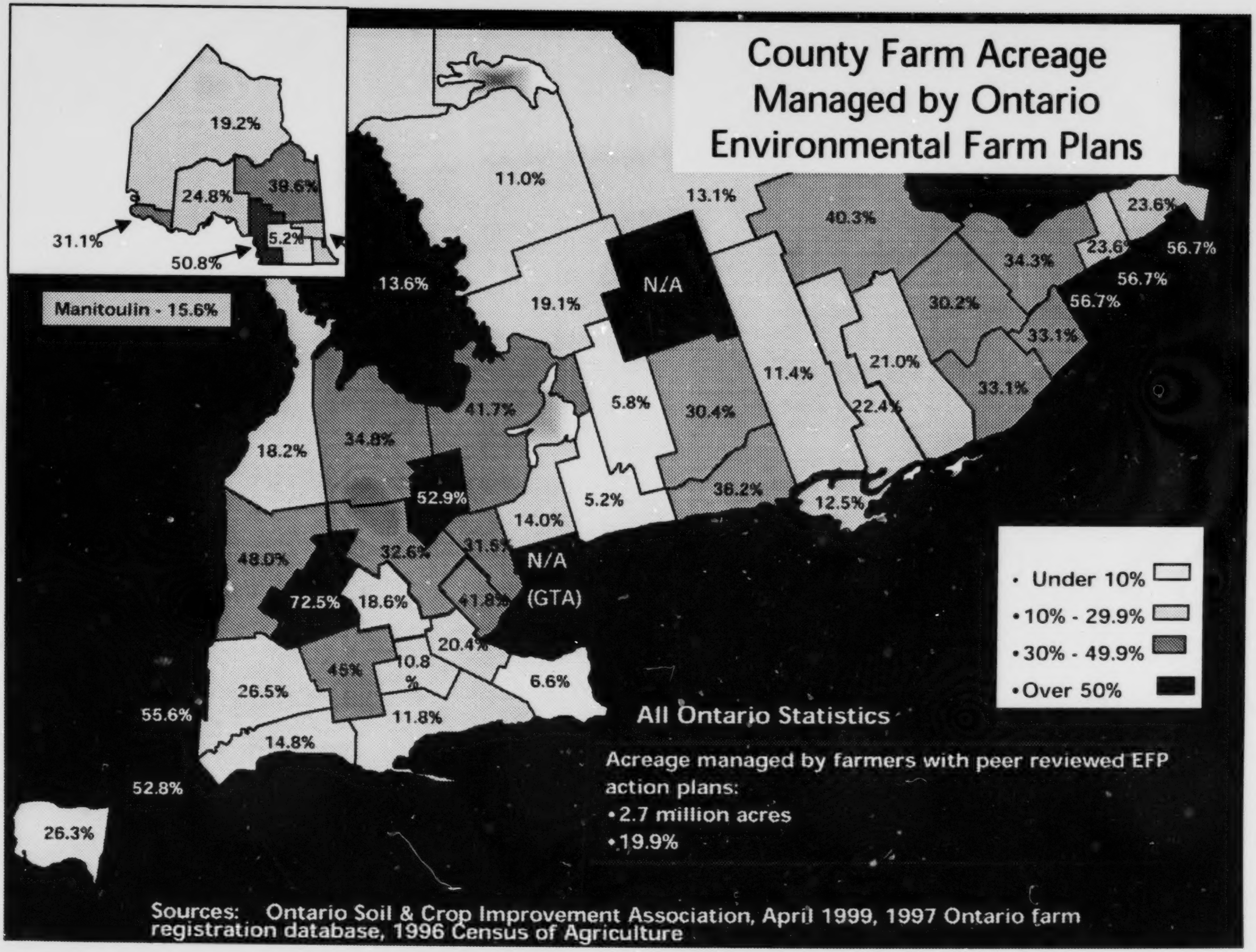
- 38 percent reduction in U.S. soil erosion
- Replenishment of organic content
- Increasing cooperation between farm community and water quality management programs

Conservation Systems Planned
Total Acres - All Land Uses


US Great Lakes Watershed
states
planned
0 - 5000
5000 - 15000
15000 - 25000
25000 - 140000

source: USDA NRCS PRMS August 2000

County Farm Acreage Managed by Ontario Environmental Farm Plans


19.2%
24.8%
39.6%
5.2%
31.1%
50.8%
Manitoulin - 15.6%
11.0%
13.1%
40.3%
23.6%
23.6
56.7%
56.7%
56.7%
34.3%
13.6%
19.1%
N/A
30.2%
33.1%
33.1%
21.0%
11.4%
22.4%
41.7%
5.8%
30.4%
18.2%
34.8%
52.9%
14.0%
5.2%
36.2%
12.5%
48.0%
32.6%
31.5%
N/A
(GTA)
72.5%
18.6%
41.8%
20.4%
45%
10.8 %
26.5%
6.6%
55.6%
11.8%
14.8%
52.8%
26.3%

- Under 10% ☐
- 10% - 29.9% ▨
- 30% - 49.9% ▨
- Over 50% ■

All Ontario Statistics

Acreage managed by farmers with peer reviewed EFP action plans:
- 2.7 million acres
- 19.9%

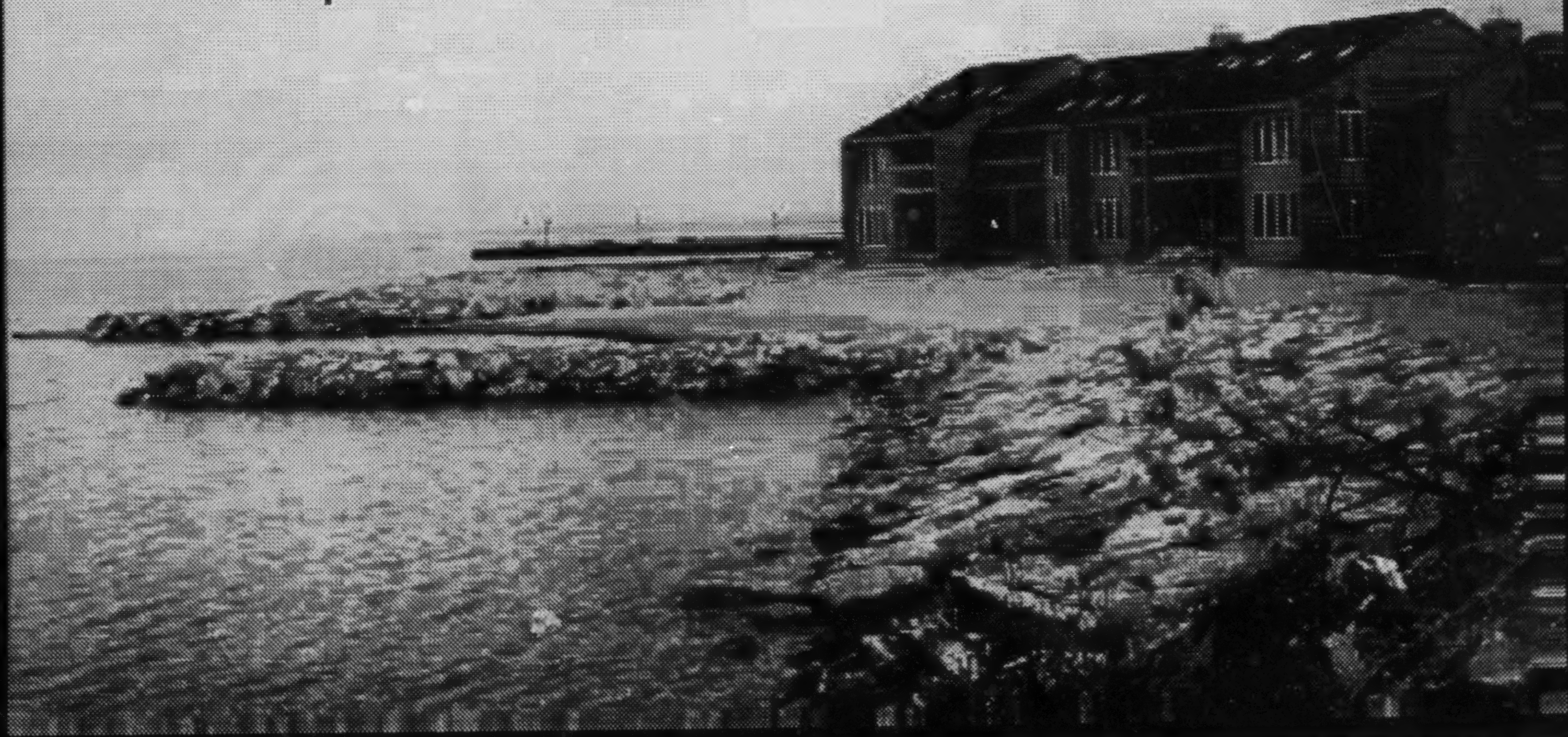
Sources: Ontario Soil & Crop Improvement Association, April 1999, 1997 Ontario farm registration database, 1996 Census of Agriculture

Sustainable Agriculture

- Voluntary conservation programs provide incentives
- Urbanizing farmland may limit future options for sustainable agriculture
- Difficult to track due to changes in ownership and use
- **State: mixed**

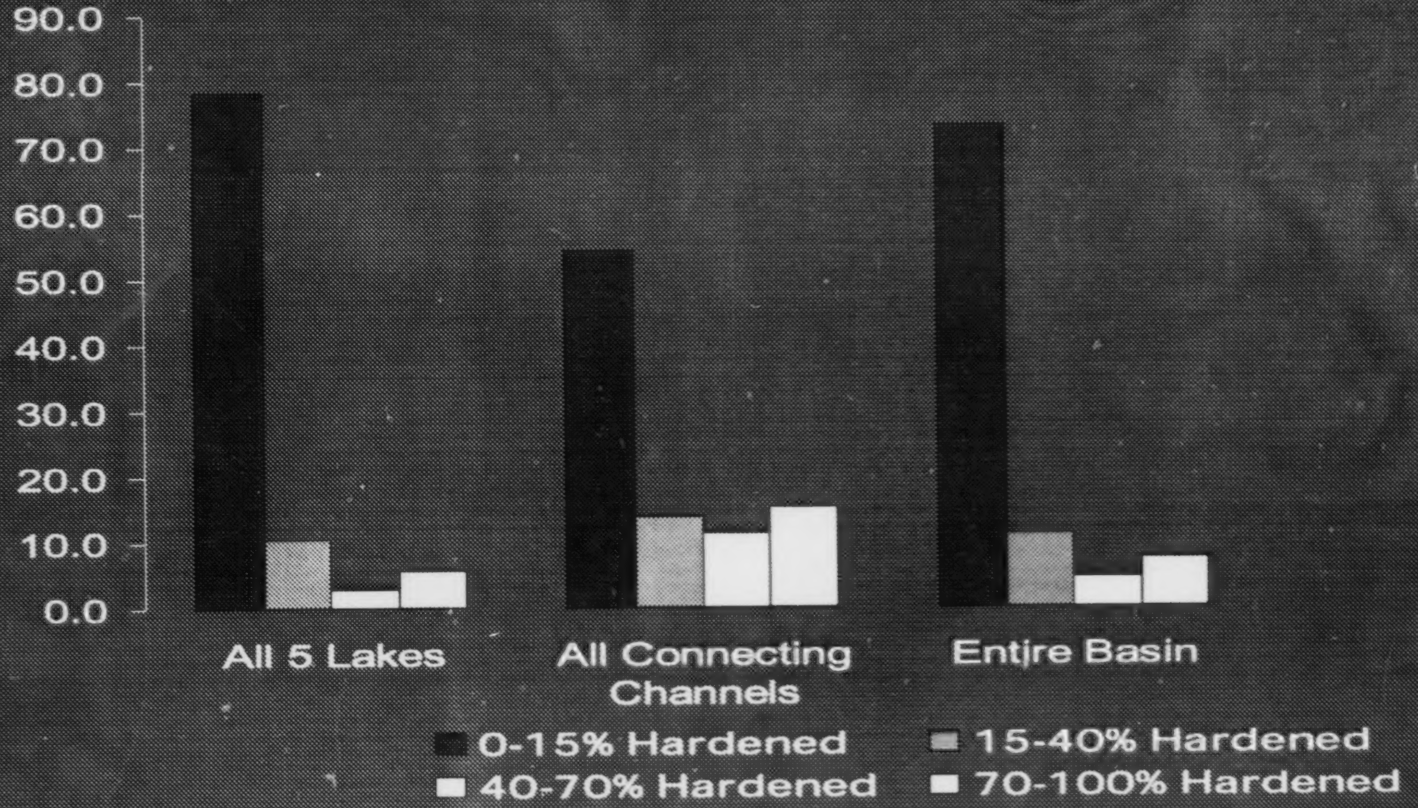
Hardened Shoreline

- Destroys natural features and biological communities
- Disrupts flow of materials along shore



Hardened Shoreline

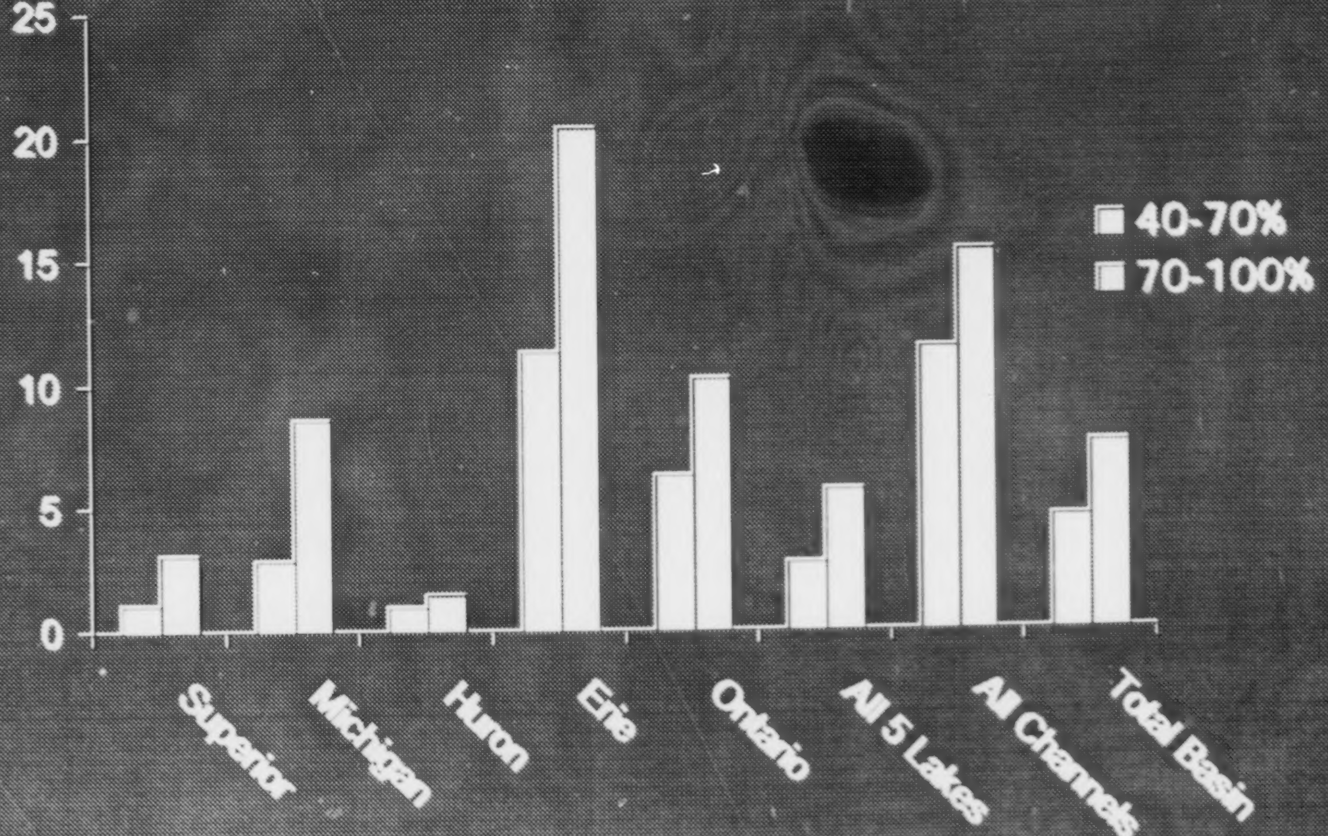
More hardening in connecting channels



Hardened Shoreline

Lake Erie has most hardening of the Lakes

Lakes Huron and Superior have the least hardening



Hardened Shoreline

- State: mixed-deteriorating
- Generally irreversible
- Soft engineering and green infrastructure offer alternatives
- Continued pressures with higher lake levels and cyclical effects
- More recent data needed

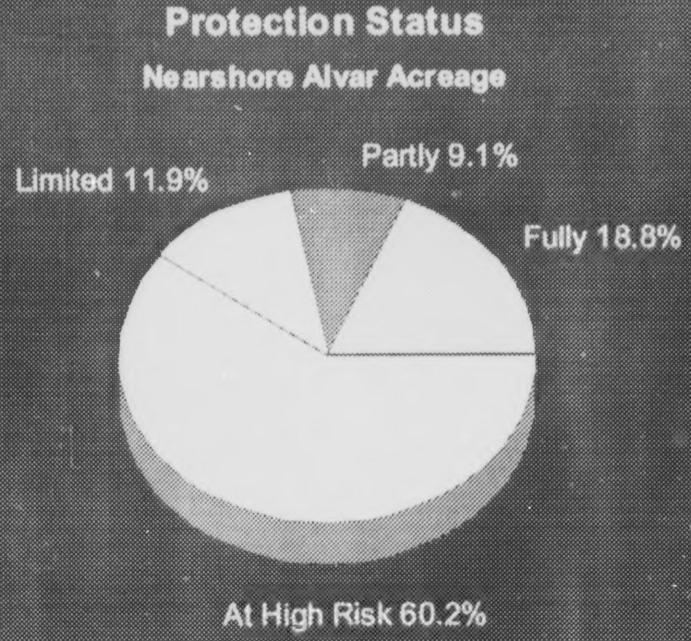
Area, Quality and Protection of Alvar Communities

- "Naturally open habitats on flat limestone bedrock"
- All 15 globally imperiled or rare
- Most remaining in Ontario
- Mostly in nearshore areas

	Total in Basin	Near-shore
# of Alvar sites	82	52
# of Community occurrences	204	138
Alvar acreage	28475	20009
Alvar acreage	28475	20009

Area, Quality and Protection of Alvar Communities

- **State: mixed**
- Less than one-fifth fully protected
- Over three-fifths at high risk
- Ongoing threats from development, recreation, and resource extraction



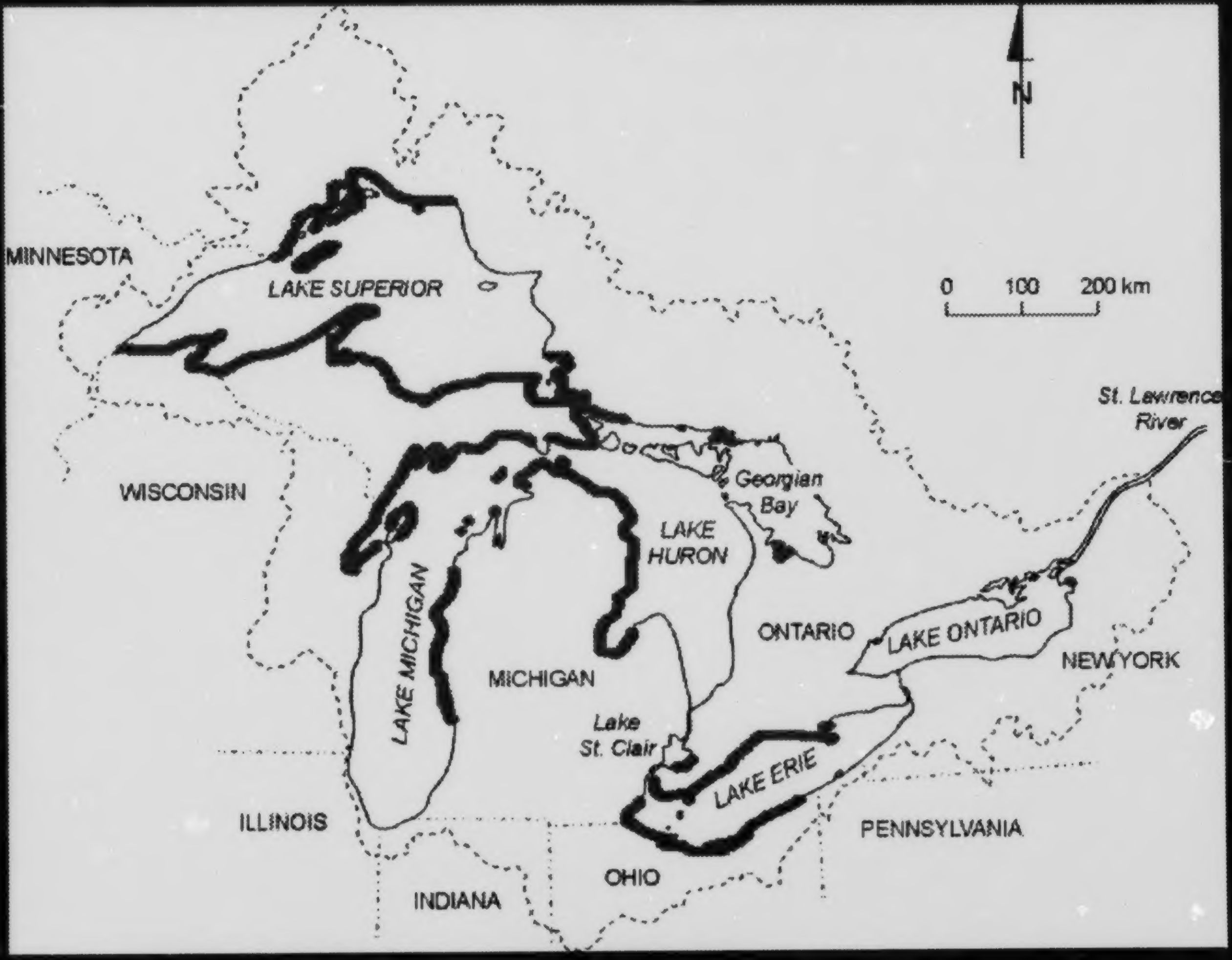
Protection Status

Nearshore Alvar Acreage

Contaminants Affecting Bald Eagle Productivity

- Recovery from near extinction
- Levels in Michigan eagles stable or declining since 80s and early 90s
- No apparent contaminant trends basinwide
- Increase in developmental deformities basinwide
- Increase in population of young basinwide

Approximate Nesting Locations of Bald Eagles


N
0 100 200 km
MINNESOTA
LAKE SUPERIOR
WISCONSIN
LAKE MICHIGAN
MICHIGAN
LAKE HURON
Georgian Bay
ONTARIO
LAKE ONTARIO
St. Lawrence River
NEW YORK
Lake St. Clair
LAKE ERIE
PENNSYLVANIA
ILLINOIS
INDIANA
OHIO

Contaminants Affecting Bald Eagle Productivity

- **State: mixed-improving**
- Continued threats from toxic substances, nest disturbance and shoreline development
- Need improved sampling and monitoring for nesting, contaminant levels and productivity

Summary of Future Pressures

- Low-density urban fringe/suburban development
- Open space/farmland conversion
- Road and highway development
- Intensive nearshore recreation

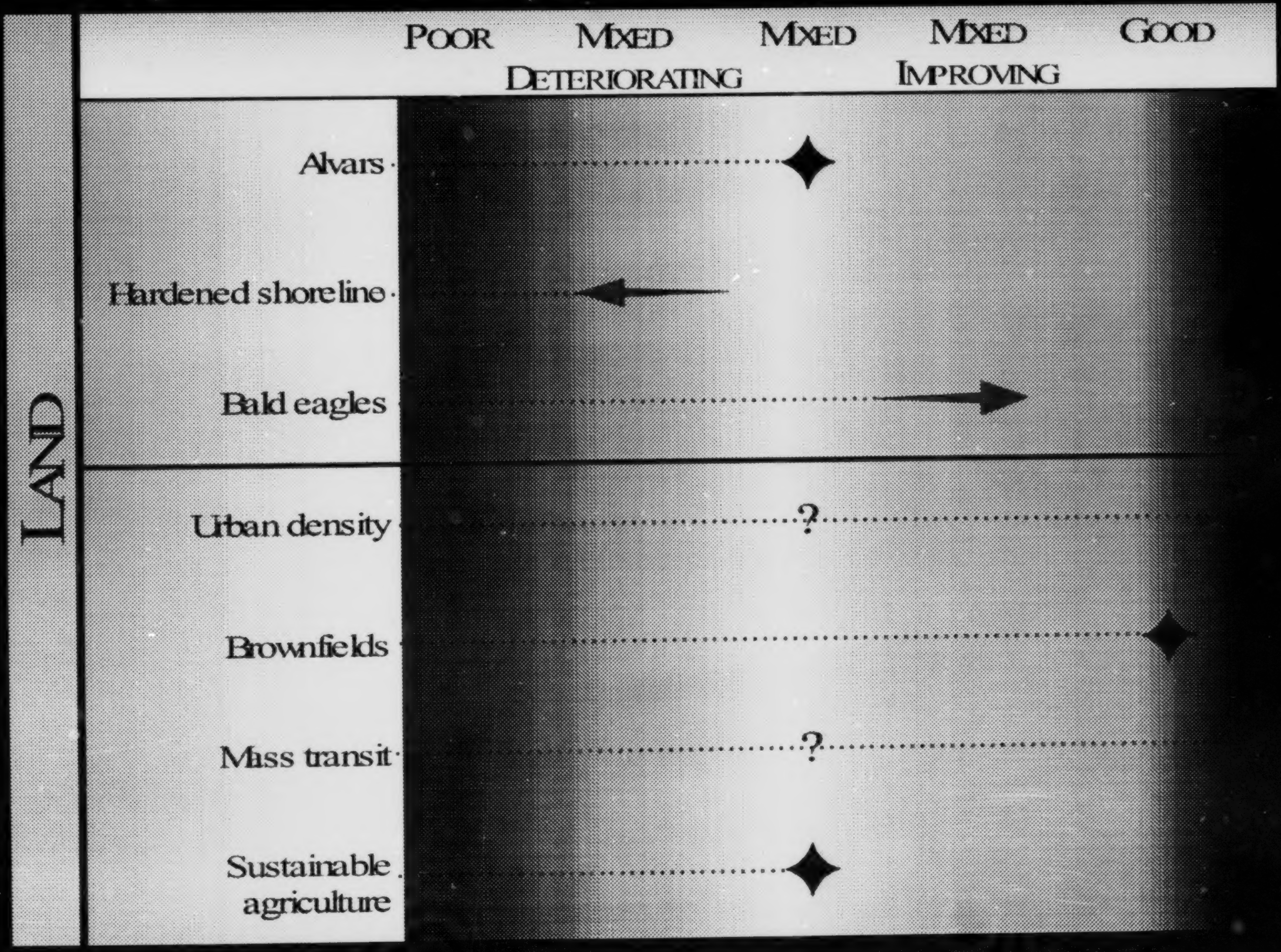
Mitigation Measures Needed

- More compact development
- Disincentives/removal of incentives for low-density sprawl
- "Livable" cities and towns (improved urban infrastructure)
- Protection of high-risk farmland and ecologically important communities
- "Soft" engineering and planning for nearshore development

Summary of Indicators

- Valuable for ecosystem assessment
- Much indicator information incomplete
- Systematic, comparable, monitoring, surveys and other data collection for each indicator
- Information needed for other land/terrestrial indicators

Conclusions



Acknowledgements

- Urban Density and Mass Transit: Ray Rivers and John Barr
- Brownfields Redevelopment: Victoria Pebbles, Great Lakes Commission
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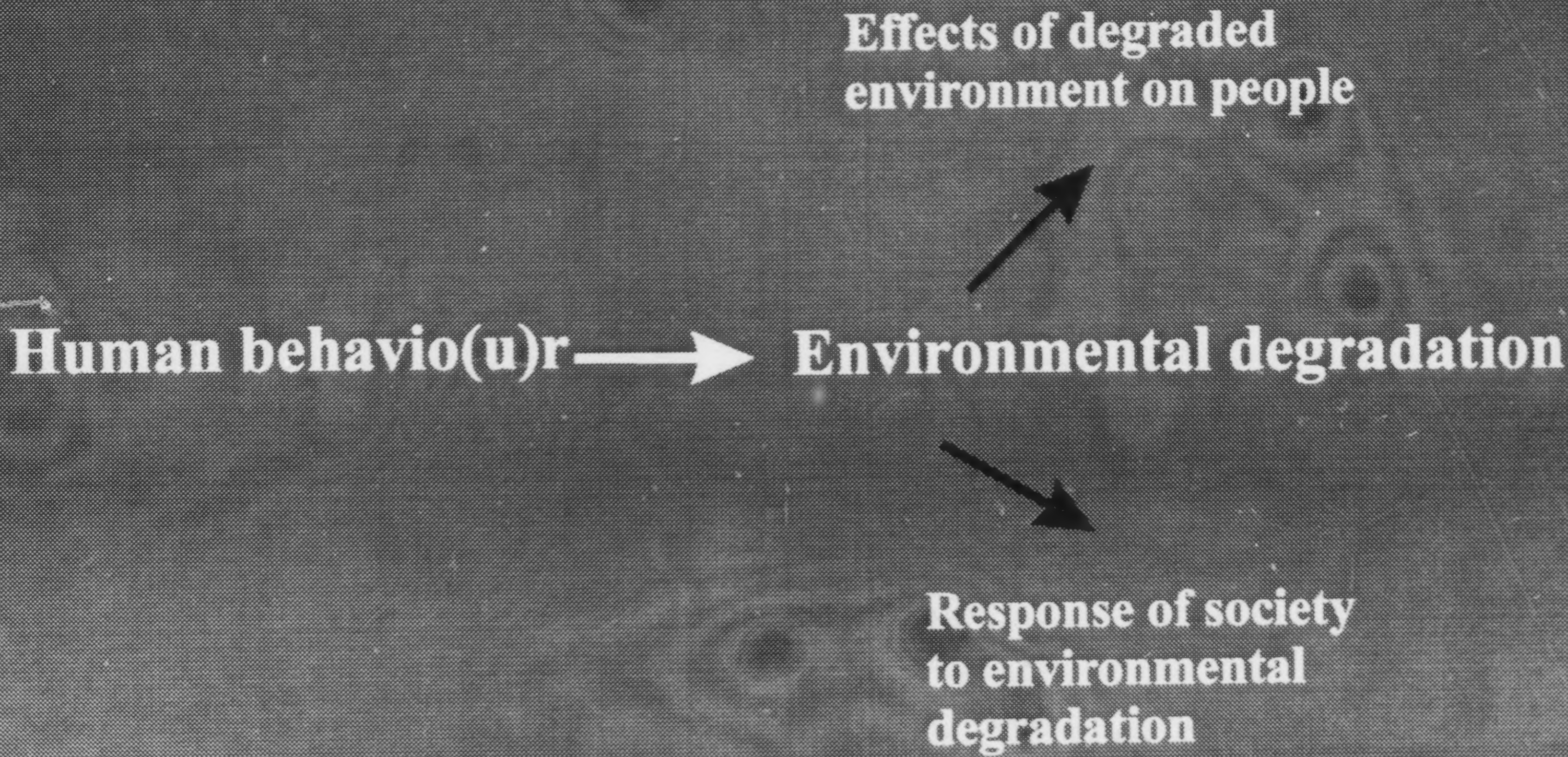
- Extent Hardened Shoreline: John Schneider and Duane Heaton, U.S. EPA Great Lakes National Program Office; Harold Leadley, Environment Canada
- Area, Quality and Protection of Alvar Communities: Heather Potter, The Nature Conservancy; Ron Reid, Bobolink Enterprises
- Contaminants Affecting Bald Eagle Productivity
- William Bowerman, Clemson University; David Best, U.S. Fish and Wildlife Service; Michael Gilbertson, International Joint Commission; Peter Nye, NY Department of Environmental Conservation

Societal Indicators

F. Henry Lickers
Mohawk Council of Akwesasne

The Evolution From 1998

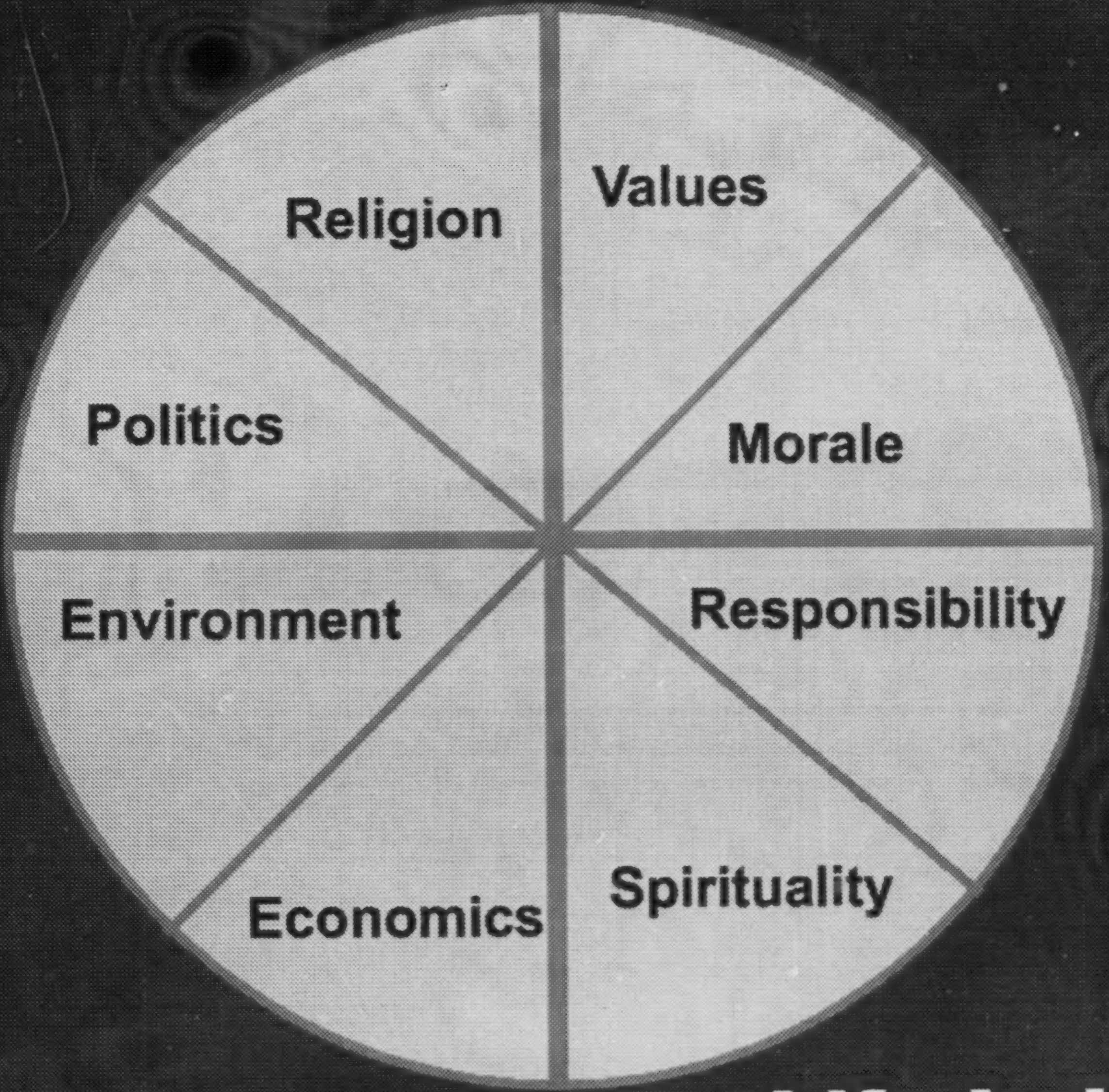
- In SOLEC 98, we talked about "stewardship"
- "Stewardship" is part of a larger concept. It stimulated the evolution to "societal"
- "Societal" brings in all aspects of sustainable communities



Human behavio(u)r → Environmental degradation

Effects of degraded
environment on people

Response of society
to environmental
degradation



Religion
Values
Politics
Morale
Environment
Responsibility
Economics
Spirituality

Life Indicators

Some Possible Indicators-
Effects on Society

- Loss of a way of life: native and non-native community cohesion
- Perception of community
- Social disruption
- Policing costs in a community
- Loss of recreational opportunities
- Economic effects
- Human health and well being

Akwesasne

- Loss of traditional way of life (fishing, hunting etc.)
- Community cohesion Increased policing costs
- Loss of recreational opportunities
- Social disruption

Hamilton

- Economic effects (loss of real estate values etc.)
- Community cohesion
- Access to waterfront
- Loss of recreational opportunities
- Social disruption

Akwesasne

- Human health and well being
  - Fish consumption; air pollution
  - Community affected by local and upstream industry

Hamilton

- Human health and well being
  - Fish consumption; swimming; air pollution
  - Community affected by local and regional industry

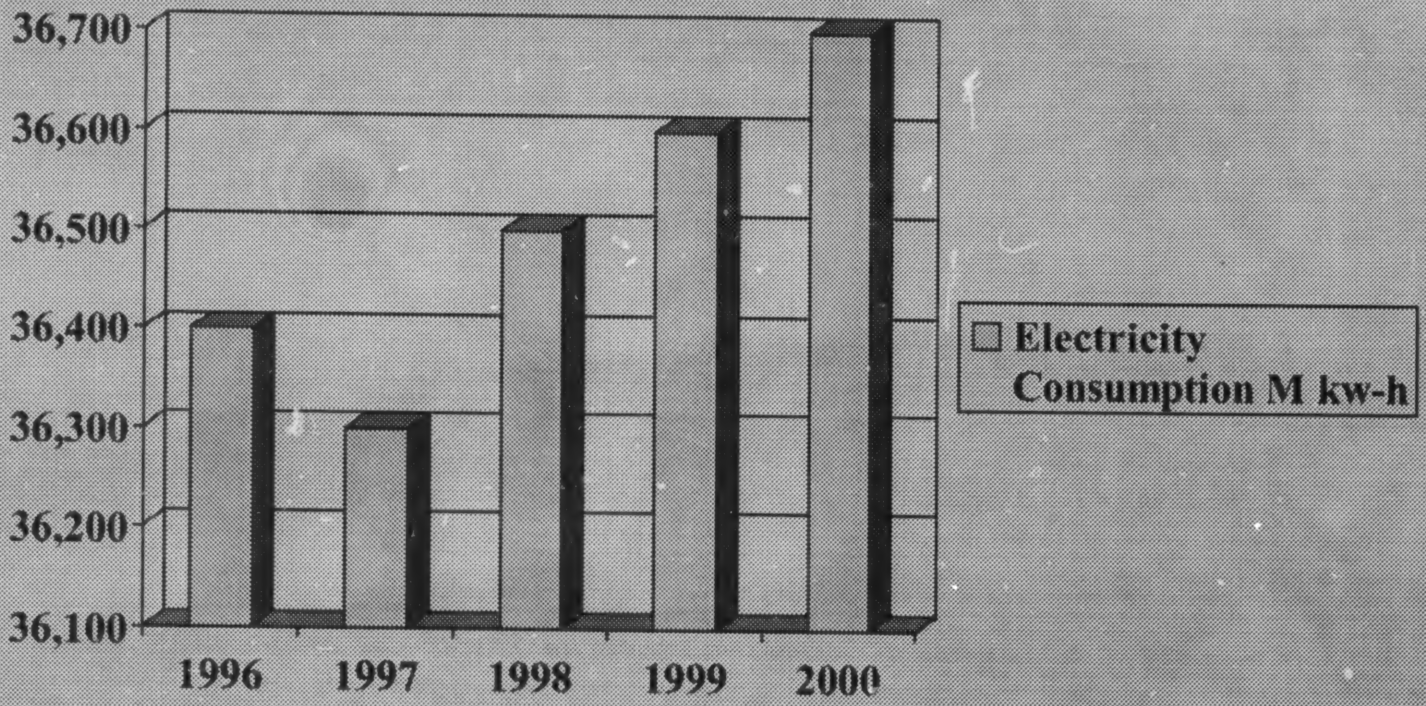
How do we respond as a society?

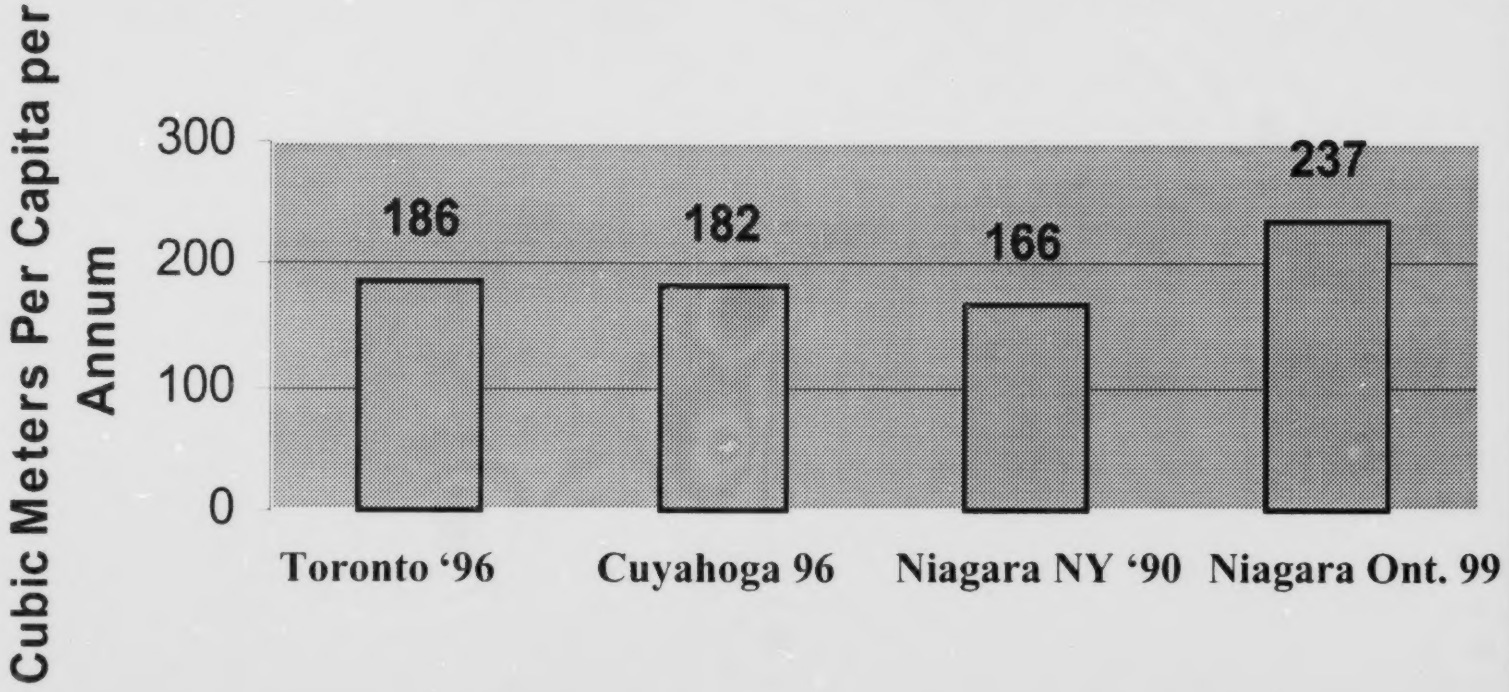
- Capacities of sustainable landscape partnerships
- Organizational richness of sustainable landscape partnerships
- Integration of ecosystem management principles across landscapes

How do we respond as a society?

- Integration of sustainability principles across landscapes
  - Economic (sustainability) prosperity
- Citizen/Community place-based Stewardship activities e.g.
  - Aesthetics
  - Water withdrawal
  - Energy consumption
  - Solid waste generation

Growth in Residential Electricity Consumption in Ontario 1996-2000





Water Use (1991-1999)

How do we respond as a society?

- Financial resources allocated to Great Lakes programs
- Naturalized knowledge systems
- Number of Areas of Concern cleaned up
- Land use planning
- Institutional capacity
- Promoting education, public awareness and training

How do we respond as a society?

- Protecting and promoting human health
- Transfer of environmentally sound technology, cooperation and capacity-building
- Development of "Green Technology-Green Education" in schools and universities

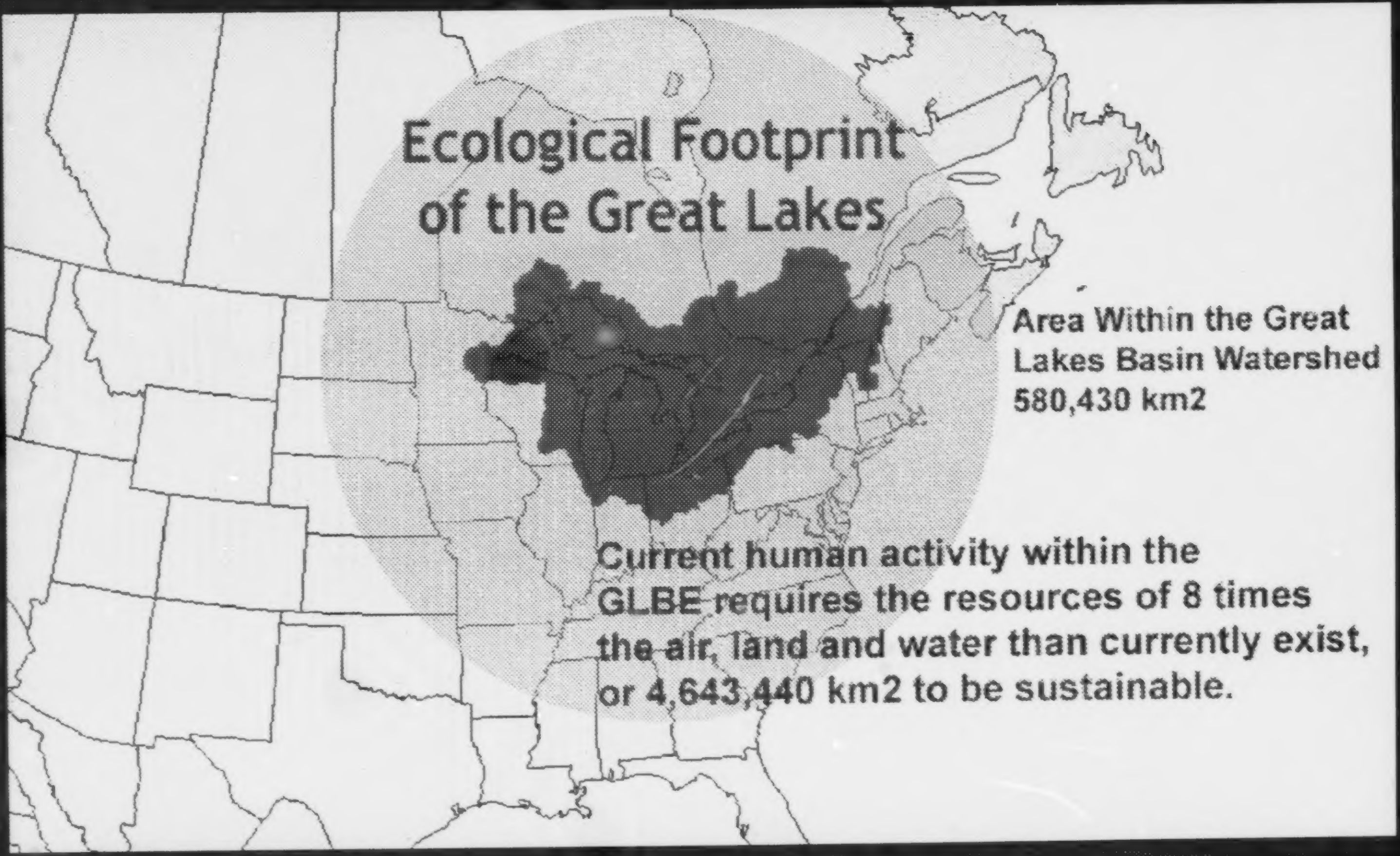
How do we respond as a society?

- Integrating environment and development in decision-making
  Information for decision-making
- Preserving forest resources
- Protection of the atmosphere

How do we respond as a society?

- More representatives of ethnic minorities and indigenous people in decision making
- Contribution of NGOs to sustainable development decisions

We need to deal with these sort of questions because our present practices are not sustainable....



Ecological Footprint of the Great Lakes

Area Within the Great
Lakes Basin Watershed
580,430 km2

Current human activity within the GLBE requires the resources of 8 times the air, land and water than currently exist, or 4,643,440 km2 to be sustainable.

Courtesy of L. Onisto, Ontario Power Generation

Focus Questions for this Afternoon

- We need objectives for the societal suite of indicators for both tracks
- Are we trying to measure sustainability?
- Are human health indicators part of "societal"

Overview of Human Health in the Great Lakes Basin

Christopher T. De Rosa

Agency for Toxic Substances
and Disease Registry

SOLEC 2000

Implementing Indicators

Persistent Toxic Substances (PTS) in the Great Lakes Basin

- **Organochlorine Compounds**
  - Polychlorinated biphenyls (PCBs)
  - Hexachlorobenzene (HCB)
  - DDT and its metabolites
  - Dioxins (2,3,7,8-TCDD)
  - Mirex
  - Dieldrin
  - Toxaphene
  - Furans

- **Heavy Metals**
  - Alkylated lead
  - Methylmercury

- **Polycyclic Aromatic Hydrocarbons**
  - Benzo[a]pyrene

Exposure

- Epidemiological studies document exposure of individuals to bioaccumulative pollutants of concern

=> Persistent toxic substances (PTS)

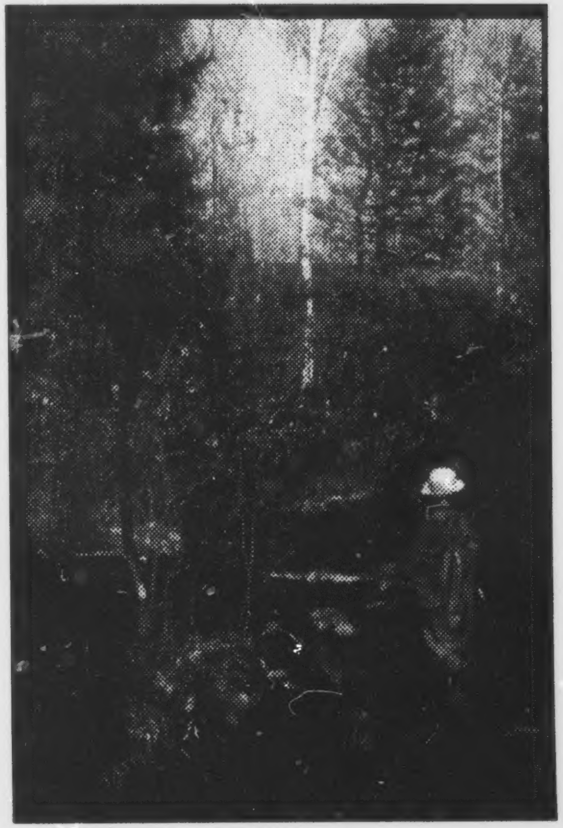
Chemical Contamination in Fish Tissue

- Levels of some contaminants in Great Lakes fish are above the advisory limits set by state and federal governments.

- 100% of the Great Lakes waters and their connecting waters are under a fish consumption advisory.

At Risk Populations

- Males/females of reproductive age
- Pregnant women
- Fetus/infant/child
- Native Americans
- Sport anglers
- Elderly
- Immuno-compromised



Health Effects

- Neurobehavioral and developmental deficits in newborns
- Disturbances in reproductive function
- Motor and cognitive deficits in adults

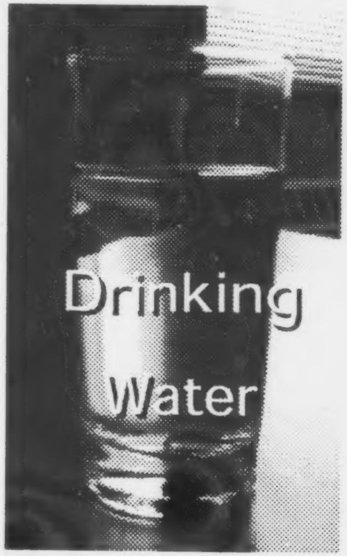
Emerging Issues for Human Health

- Air deposition of toxic substances
- Endocrine disruption
- Transgenerational effects
- Pharmaceuticals and other contaminants in water

Future Priority Needs for Human Health

- Monitoring and surveillance data
- More collaborative research efforts between the U.S. and Canada
- Binational database of human health information

Indicators for Human Health

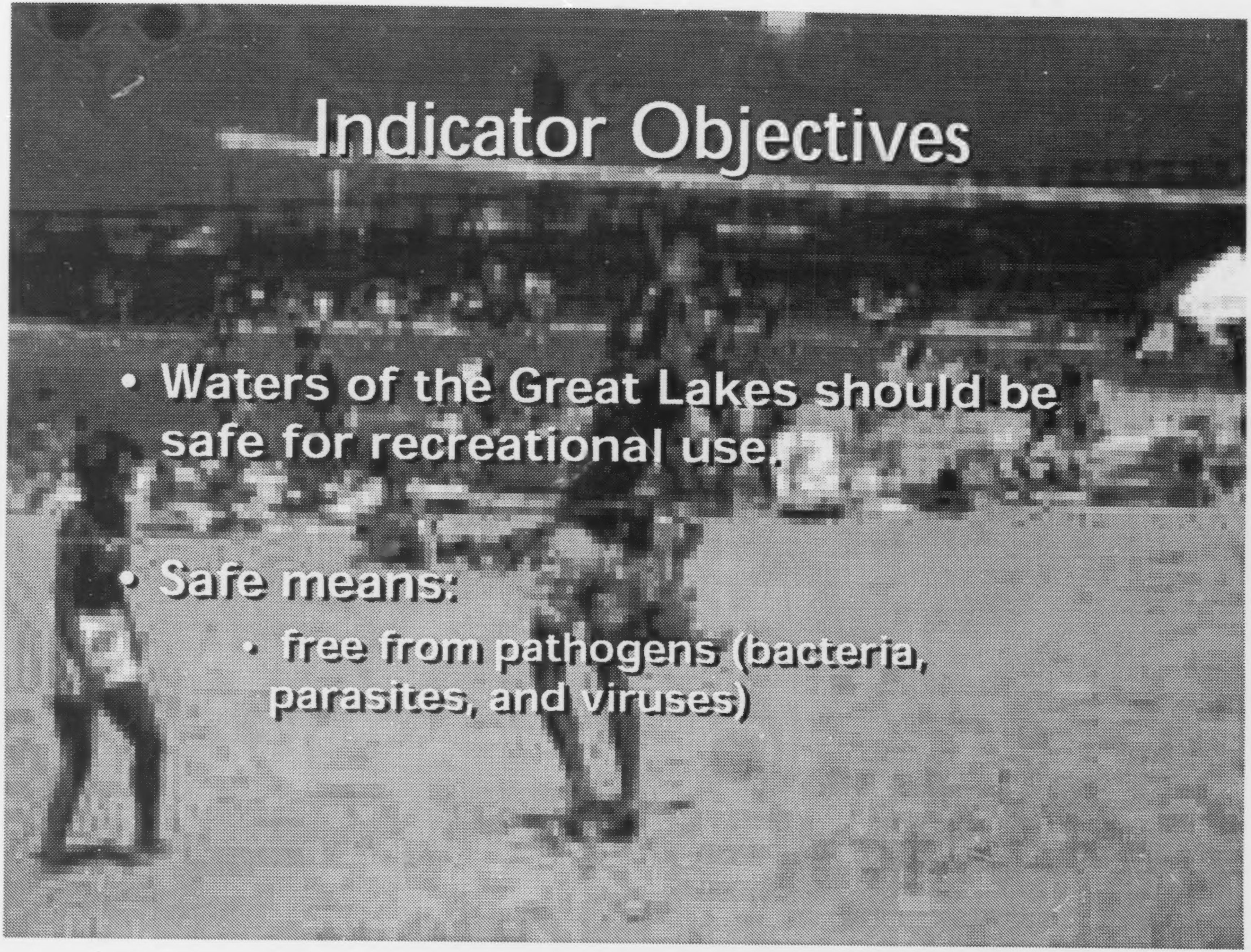

Drinking Water

Swimming Advisories

Fish Consumption Advisories

Human Health:
Swimming Advisories

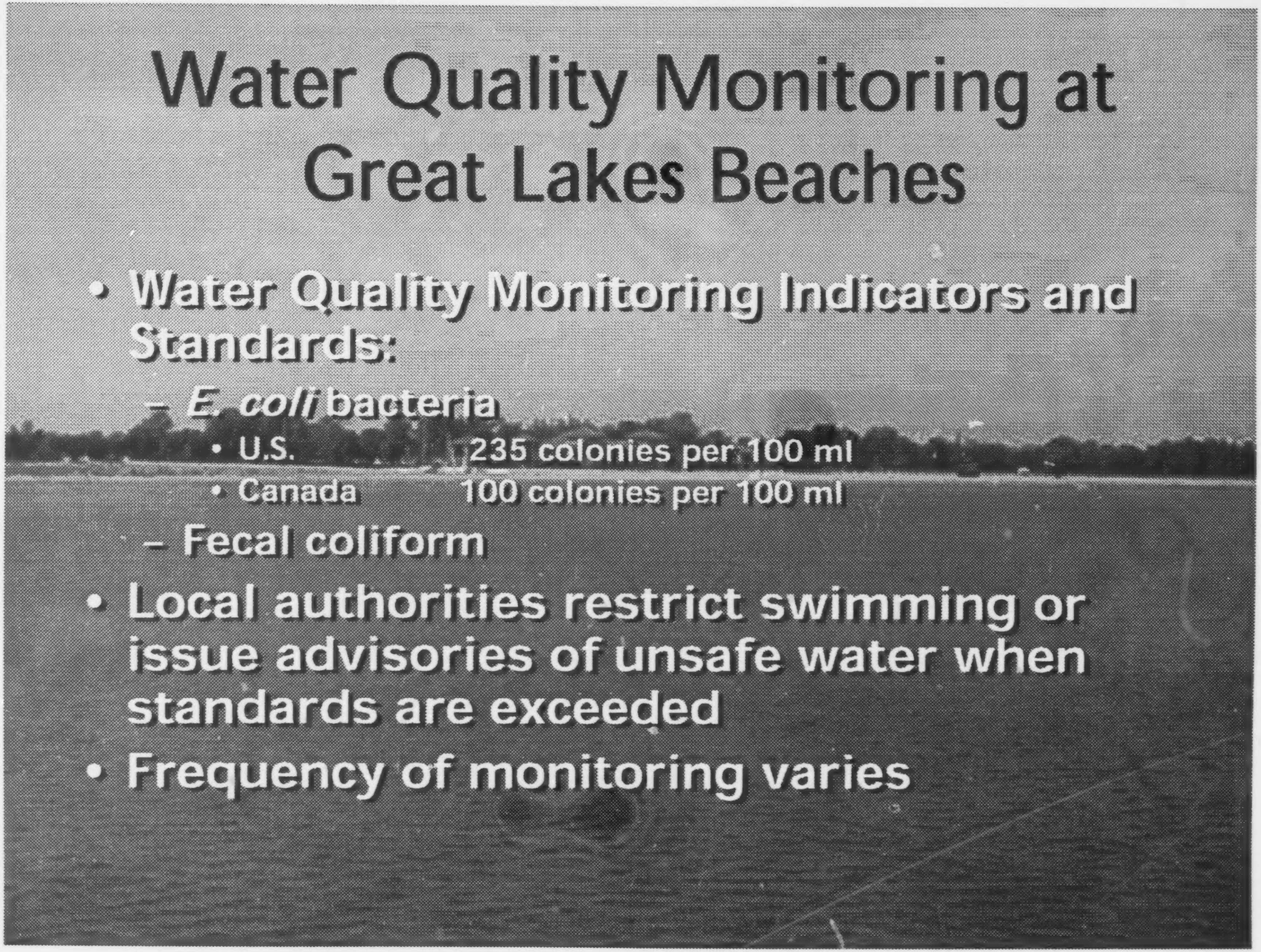
Marcia Jimenez
City of Chicago
Department of Environment



Indicator Objectives

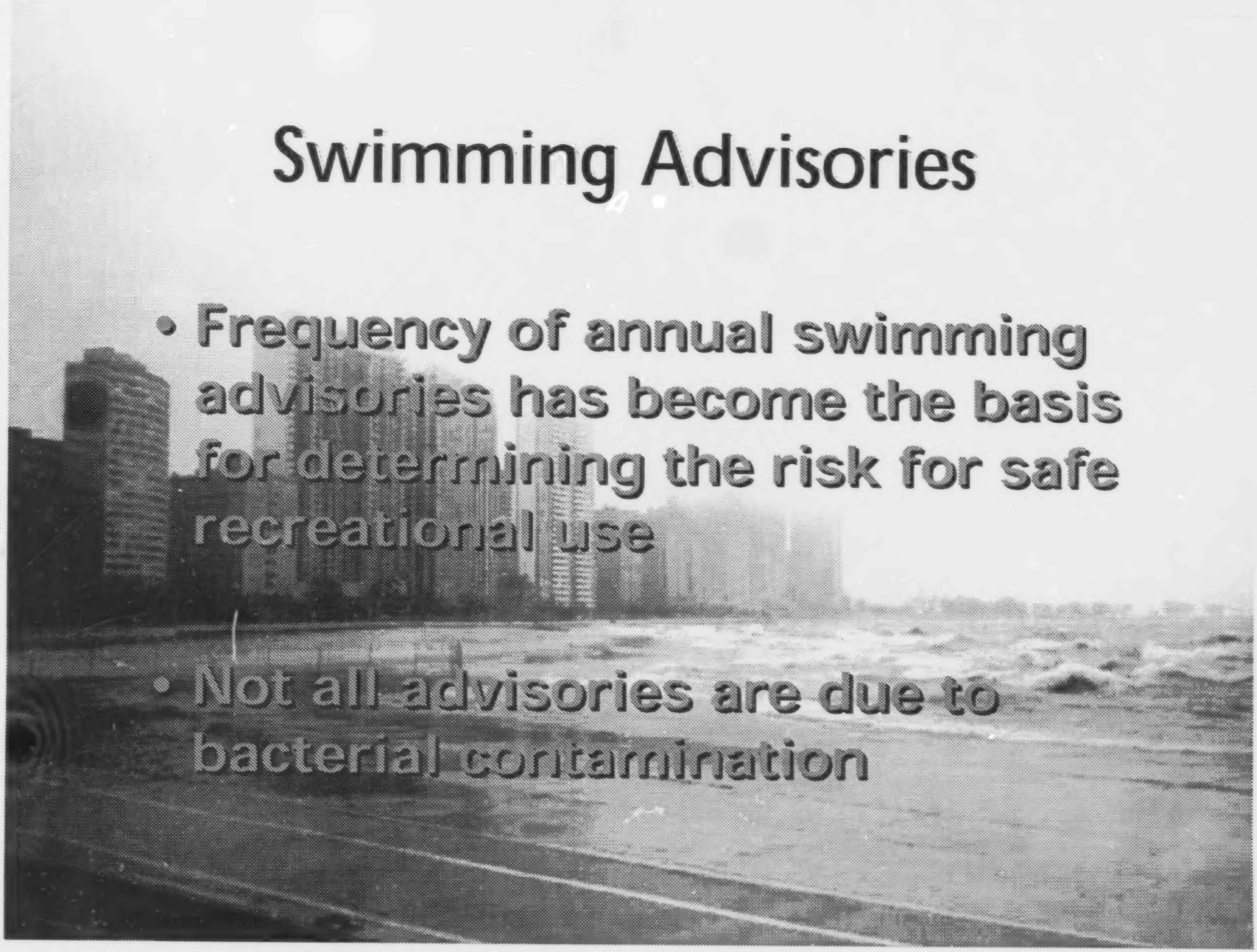
- Waters of the Great Lakes should be safe for recreational use.
- Safe means:
  - free from pathogens (bacteria, parasites, and viruses)

Water Quality Monitoring at Great Lakes Beaches



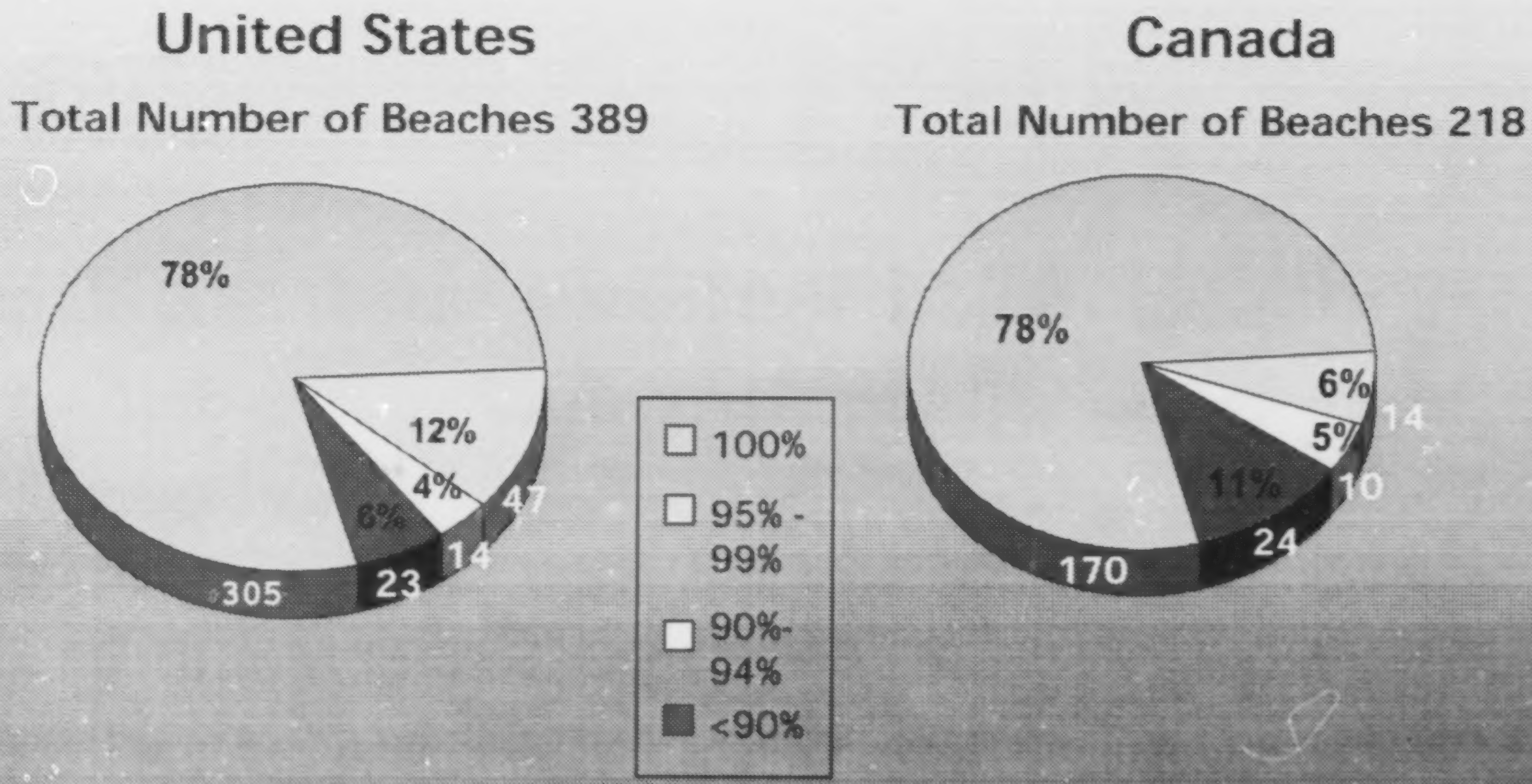
- Water Quality Monitoring Indicators and Standards:
  - *E. coli* bacteria
    - U.S. 235 colonies per 100 ml
    - Canada 100 colonies per 100 ml
  - Fecal coliform
- Local authorities restrict swimming or issue advisories of unsafe water when standards are exceeded
- Frequency of monitoring varies

Swimming Advisories

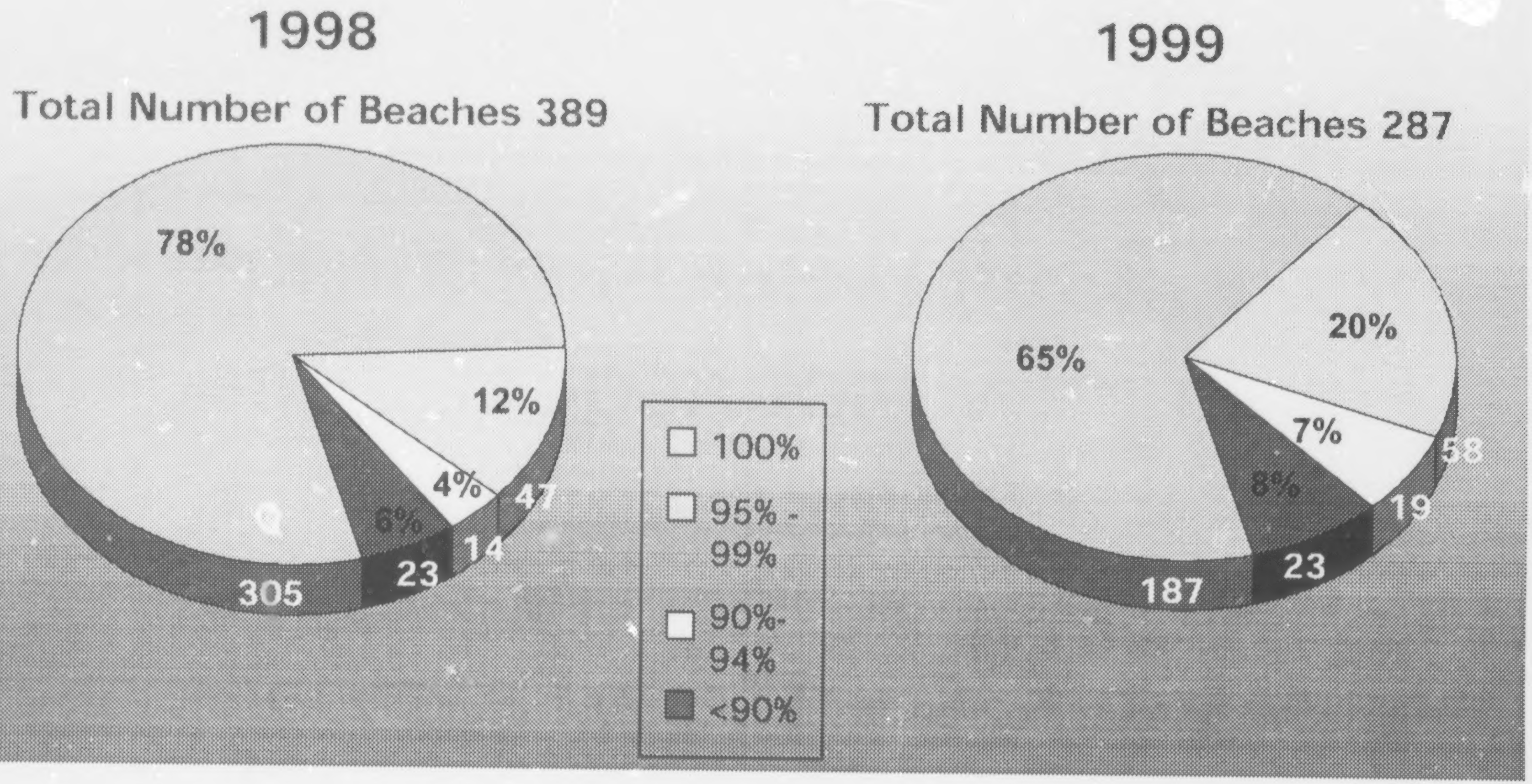


- Frequency of annual swimming advisories has become the basis for determining the risk for safe recreational use
- Not all advisories are due to bacterial contamination

Percentage of Great Lakes Beaches Open for Swimming (June-August 1998)



Percentage of U.S. Great Lakes Beaches Open for Swimming (June-August)



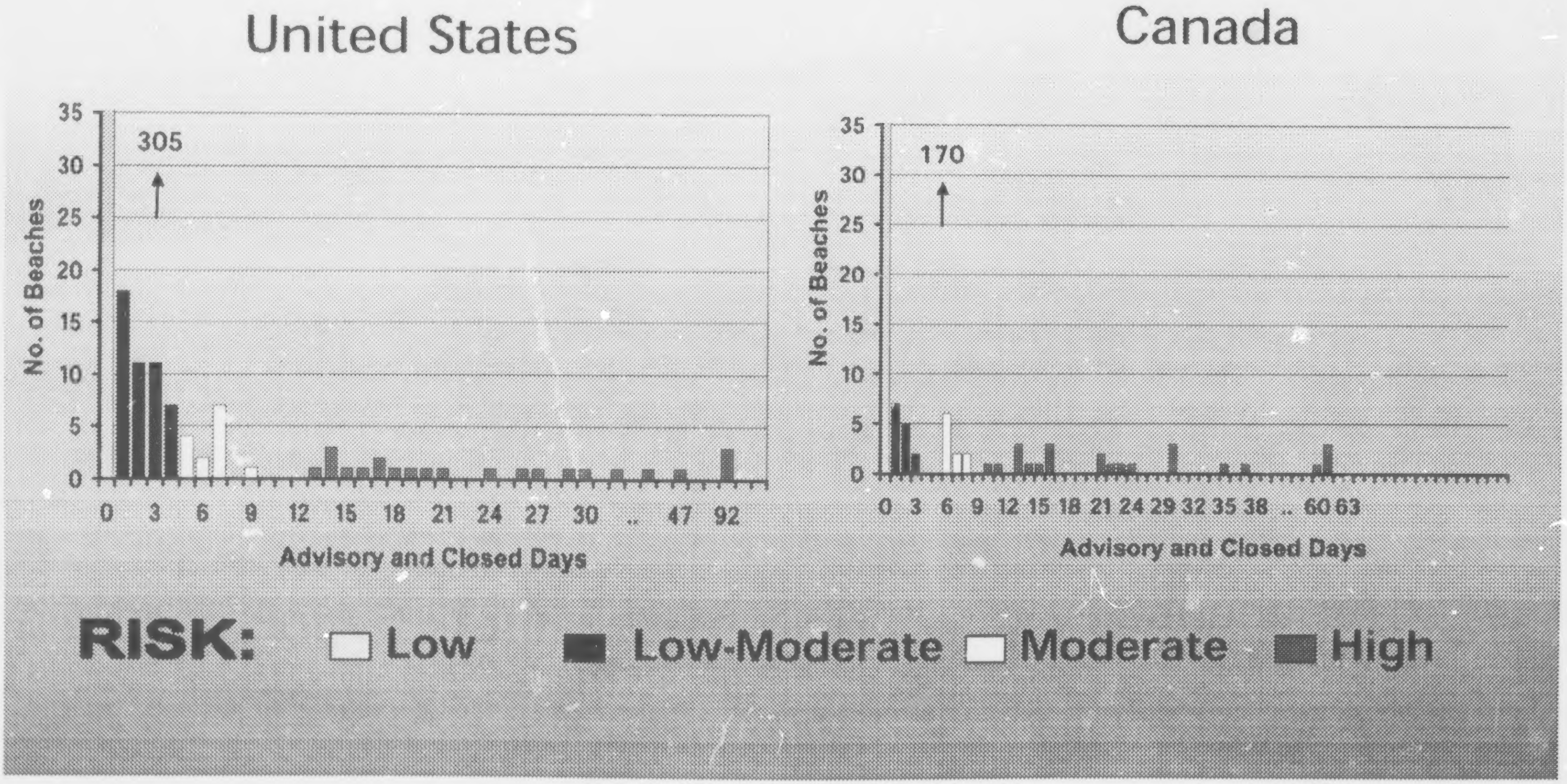
1998

Total Number of Beaches 389

1999

Total Number of Beaches 287

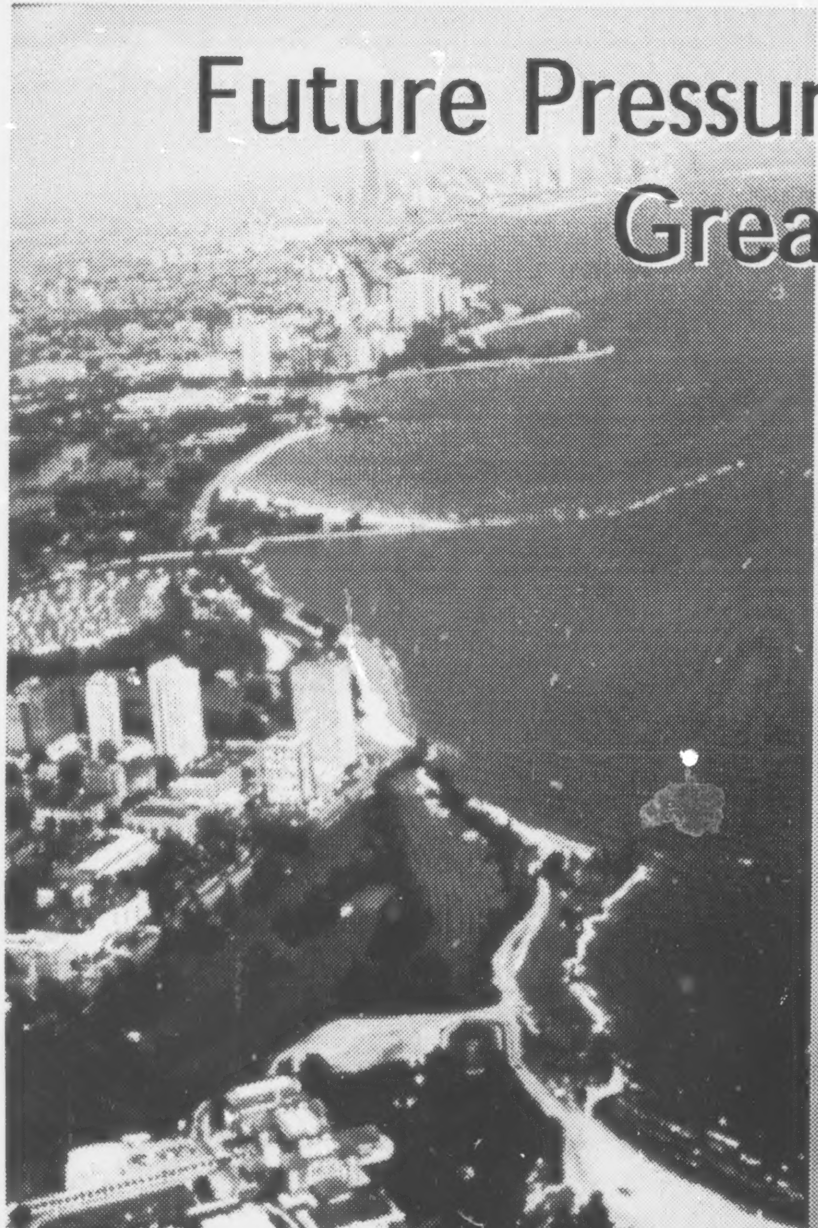
Great Lakes Swimming Advisories and Closings 1998



Swimming Advisories Survey Conclusions

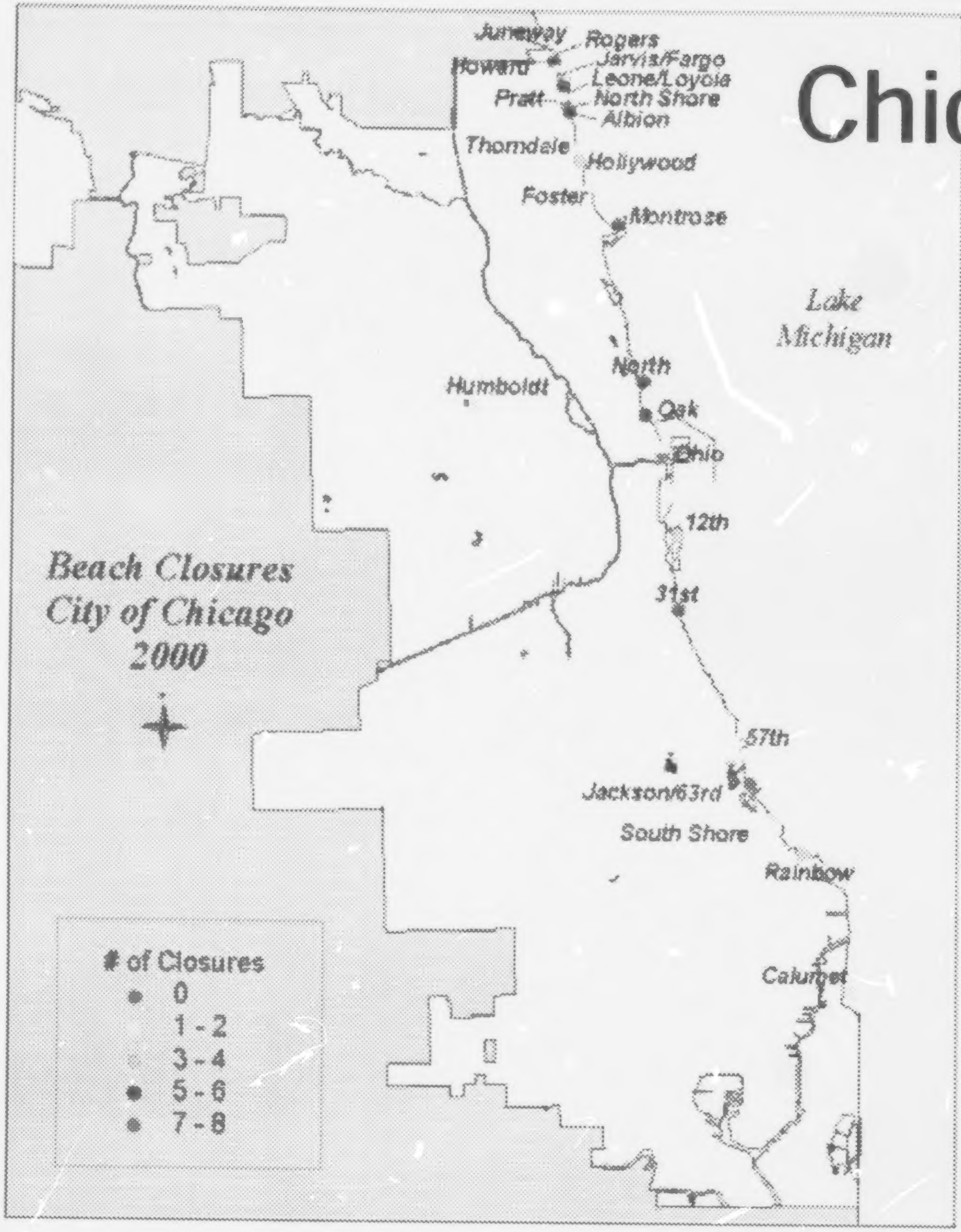
- *E. coli* is a more sensitive indicator of public health risks for swimmers
- *E. coli* tests give more consistent measurements
- Beach managers are using *E. coli* testing more frequently to advise swimmers
- *E. coli* is a "common denominator" between beaches

Future Pressures on Waters of Great Lakes



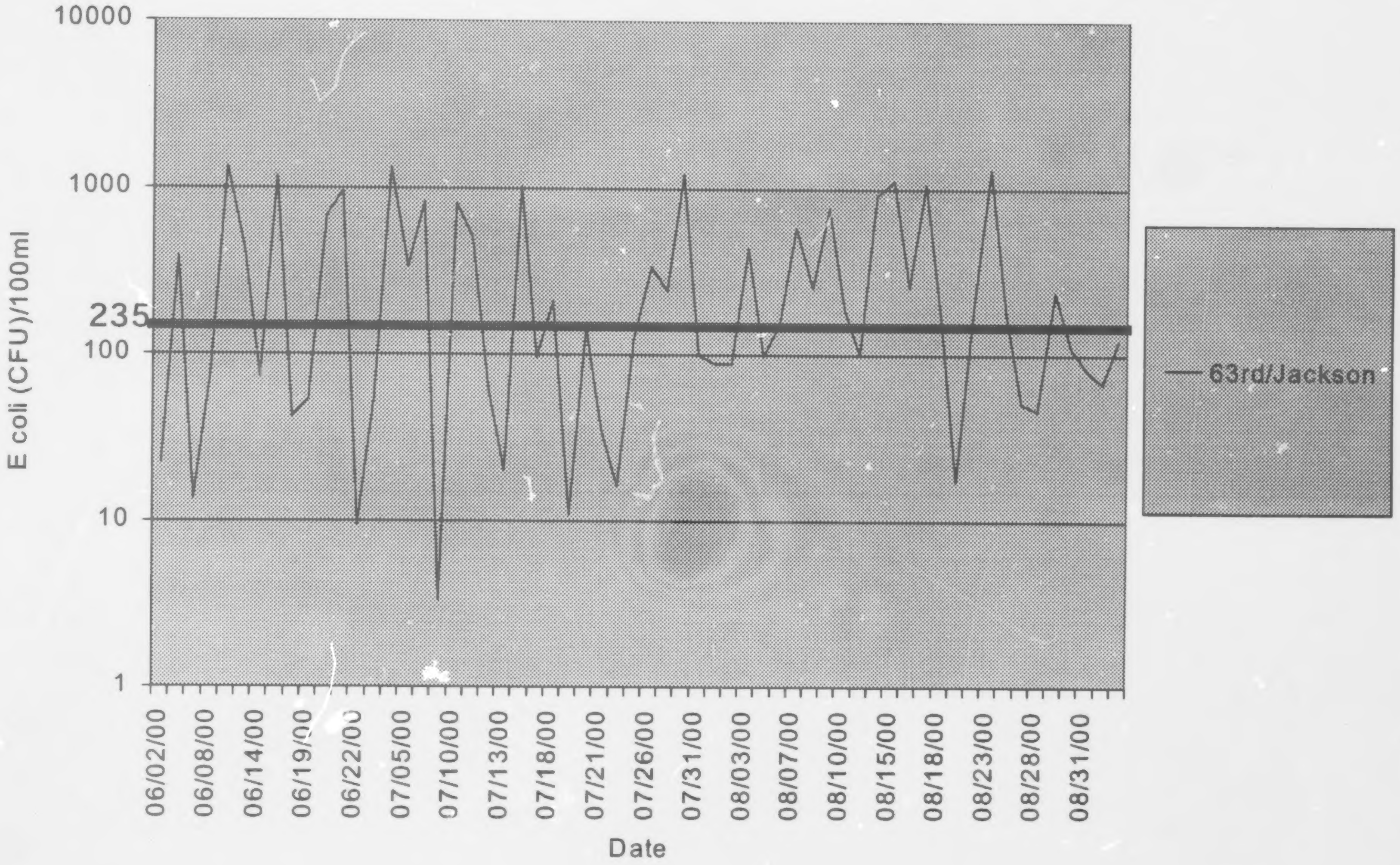
- Increased Growth of cities
- Increase in resort and vacation areas utilizing private systems
- Uncertainty of available funding for future research

Chicago Lakefront

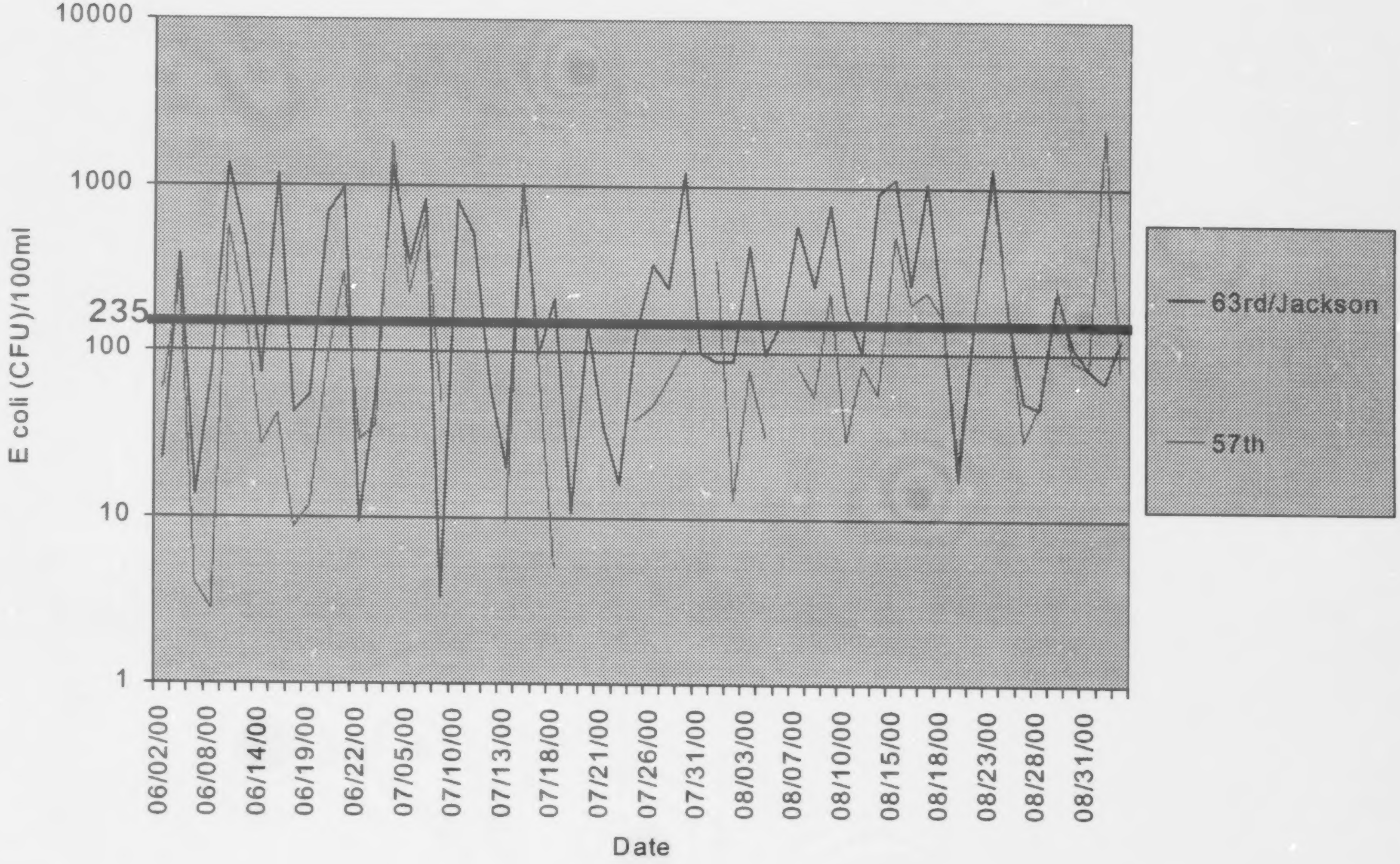

Beach Closures
City of Chicago
2000
Lake Michigan
Juneway
Rogers
Howard
Jarvis/Fargo
Leone/Loyola
Pratt
North Shore
Albion
Thorndale
Hollywood
Foster
Montrose
North
Humboldt
Oak
Ohio
12th
31st
57th
Jackson/63rd
South Shore
Rainbow
Calumet
# of Closures
0
1 - 2
3 - 4
5 - 6
7 - 8

- 28 Miles of Lakefront
- 32 Public beaches
- 4 Lakefront designs
- Millions of Users
- $5 Billion in Annual Revenue

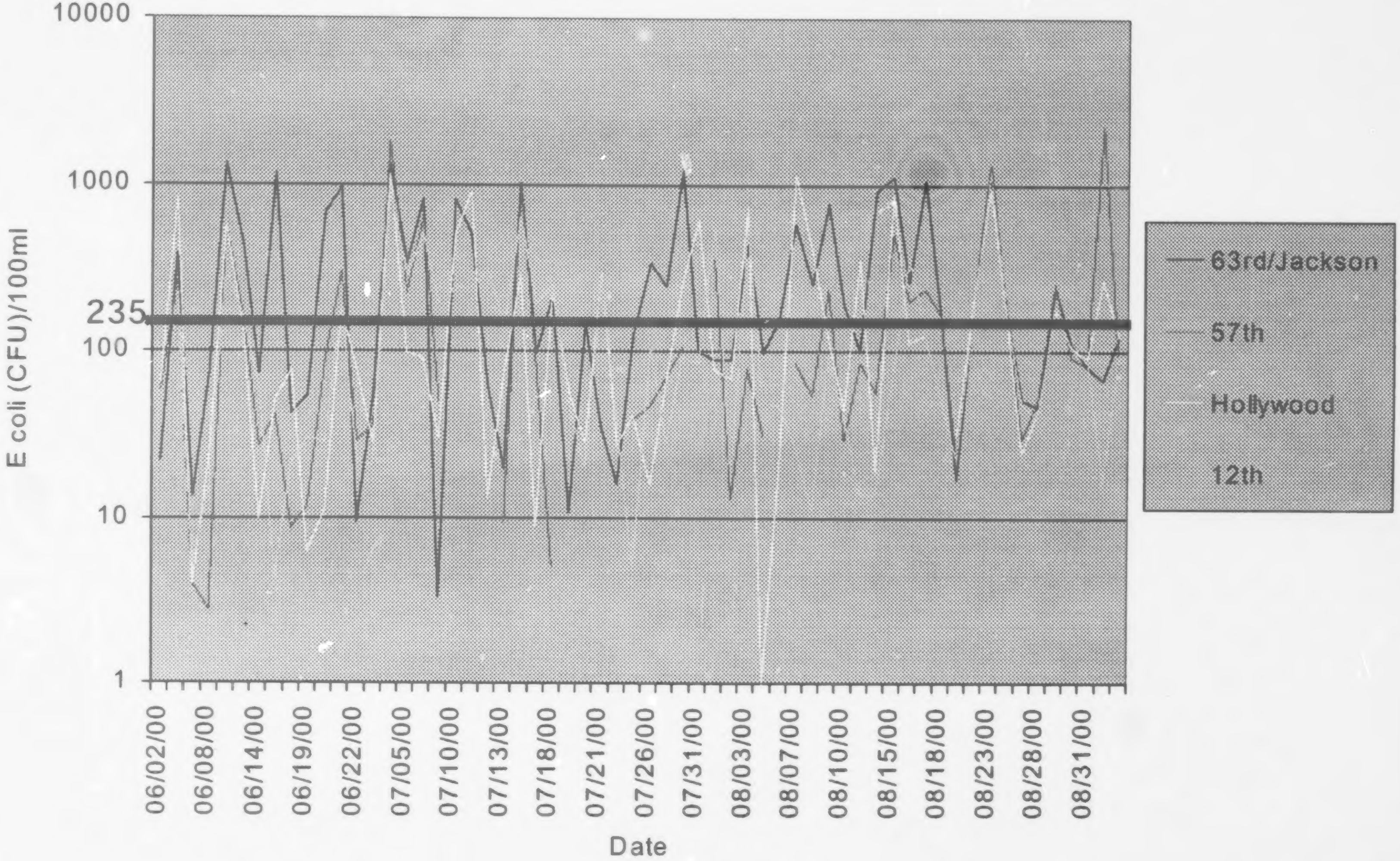
Summer 2000 *E. coli* Concentrations, Chicago Beaches



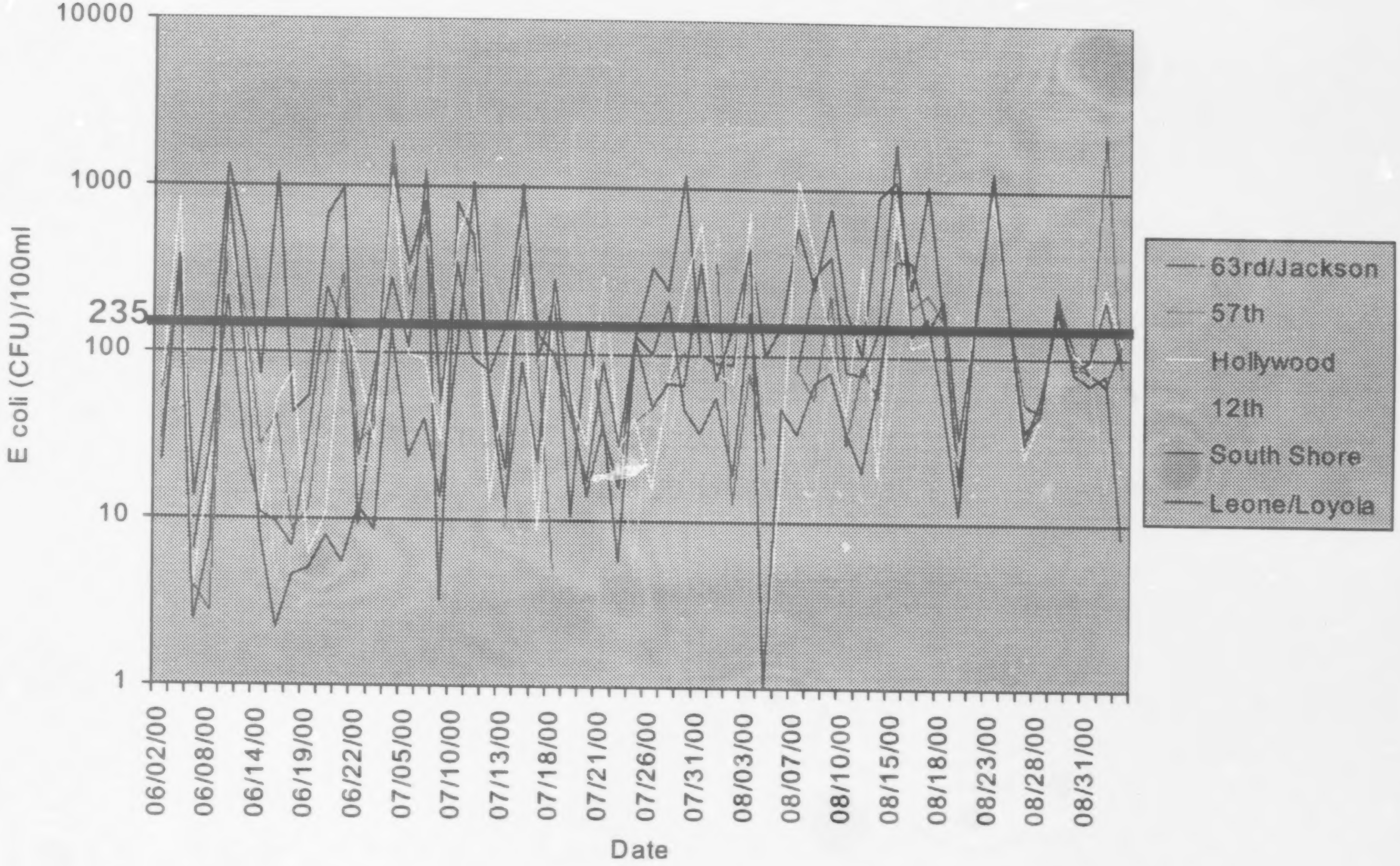
Summer 2000 *E. coli* Concentrations, Chicago Beaches



Summer 2000 *E. coli* Concentrations, Chicago Beaches



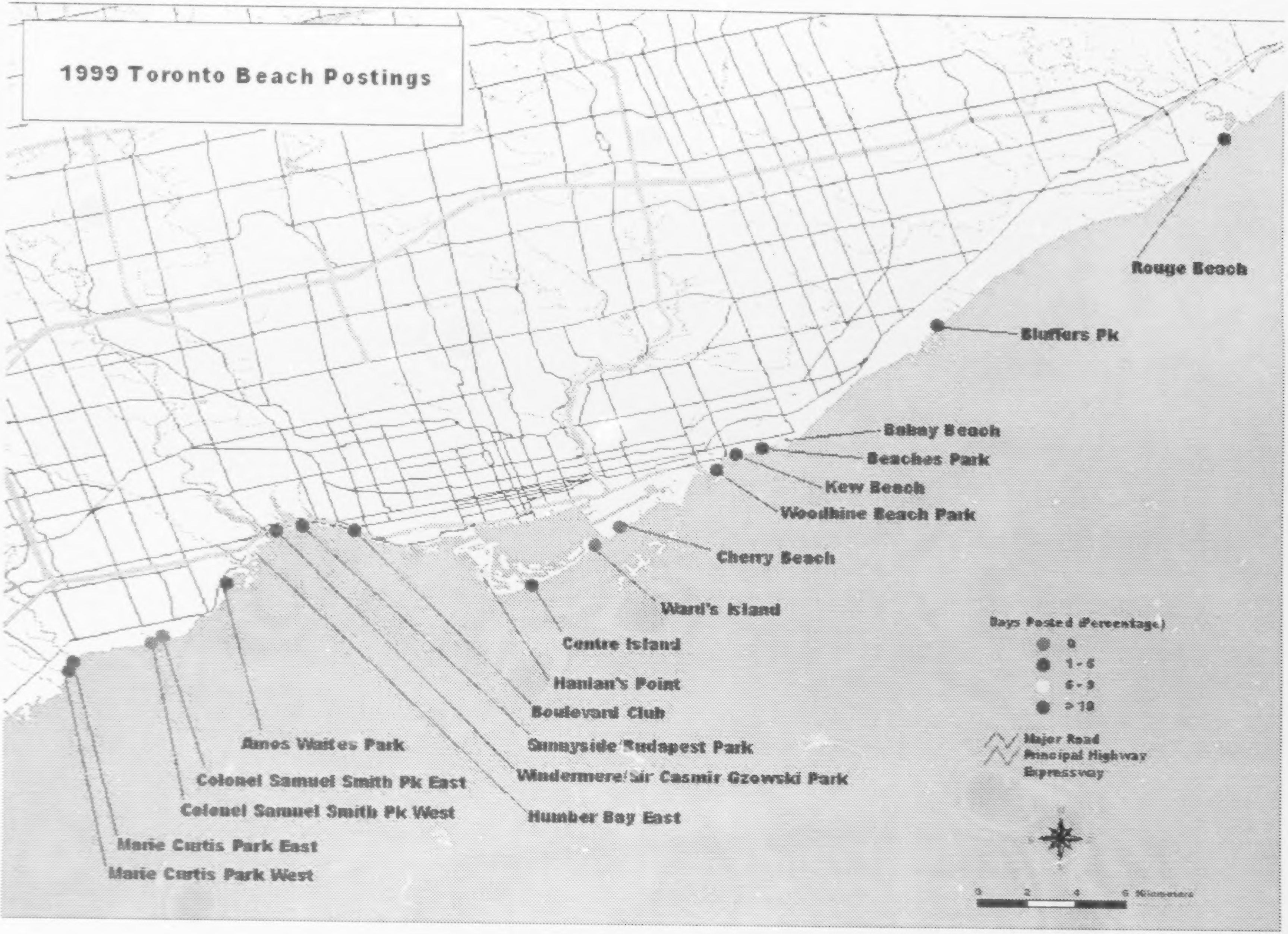
Summer 2000 *E. coli* Concentrations, Chicago Beaches



Illinois Cook County Lake Michigan Beaches

Year	Beaches with Swimming Advisories	Annual Rainfall	Comments
1981	30	39.2	LOCKS OPENED
1982	36	44.7	LOCKS OPENED
1983	36	49.4	LOCKS OPENED
1984	0	34.0	
1985	27	40.1	LOCKS OPENED
1986	2	31.7	POLLUTION/ DEEP TUNNEL OPEN
1987	36	41.4	POLLUTION
1988	0	33.4	POLLUTION
1989	22	29.5	POLLUTION
1990	14	43.1	POLLUTION
1991	13	35.0	LOCKS OPENED
1992	9	30.1	POLLUTION
1993	0	44.9	
1994	0	29.6	
1995	2	32.9	POLLUTION
1996	19	30.7	PRECAUTIONARY/POLLUTION
1997	20	31.7	
1998	8	37.5	SEWAGE
1999	27	38.2	E.coli/POLLUTION

1999 Toronto Beach Postings

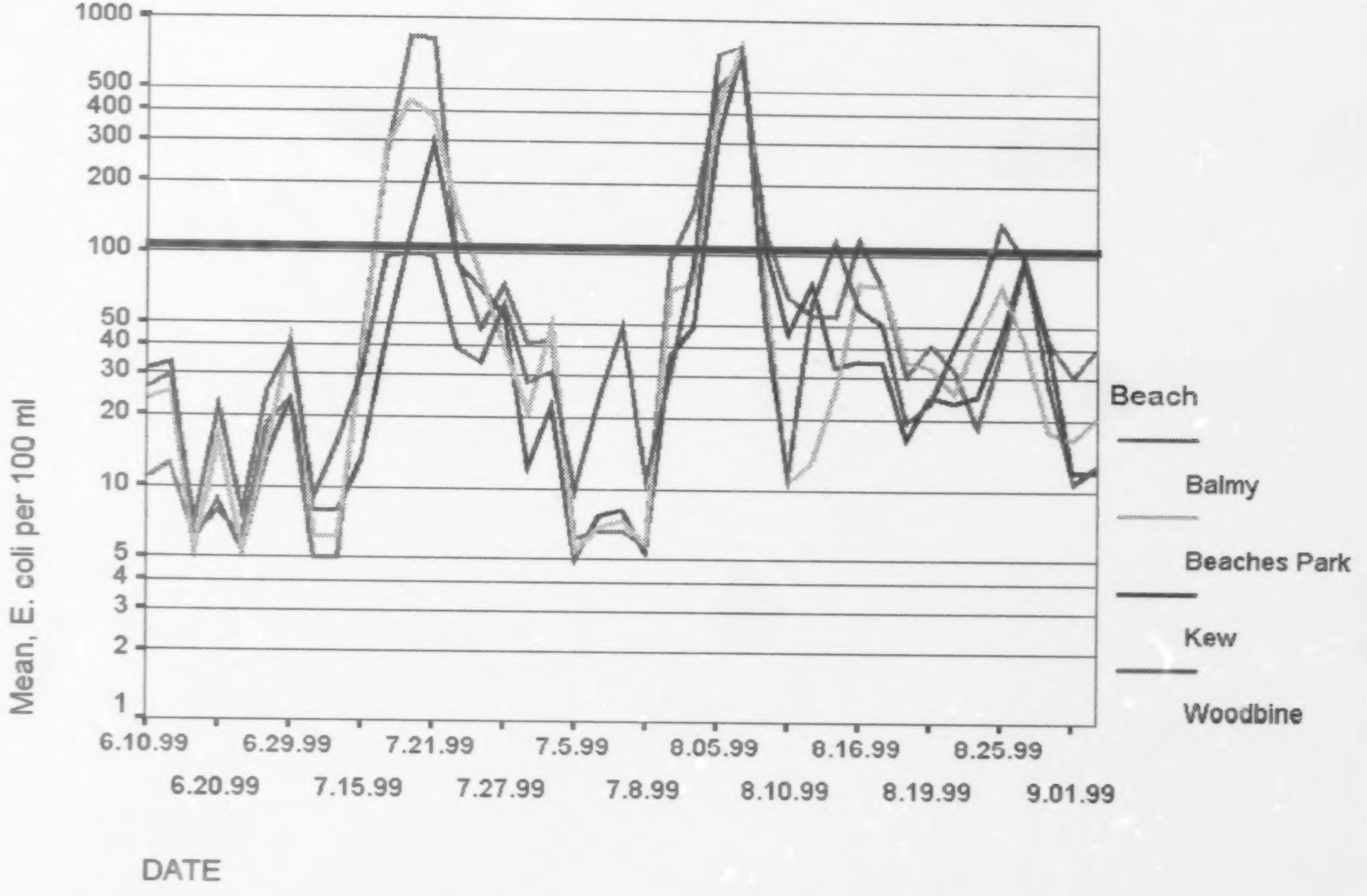

Rouge Beach
Bluffers Pk
Balmy Beach
Beaches Park
Kew Beach
Woodbine Beach Park
Cherry Beach
Ward's Island
Centre Island
Hanlan's Point
Boulevard Club
Sunnyside/Budapest Park
Windermere/Sir Casmir Gzowski Park
Humber Bay East
Amos Waites Park
Colonel Samuel Smith Pk East
Colonel Samuel Smith Pk West
Marie Curtis Park East
Marie Curtis Park West
Days Posted (Percentage)
0
1 - 5
6 - 9
> 10
Major Road
Principal Highway
Expressway
0
2
4
6 Kilometers

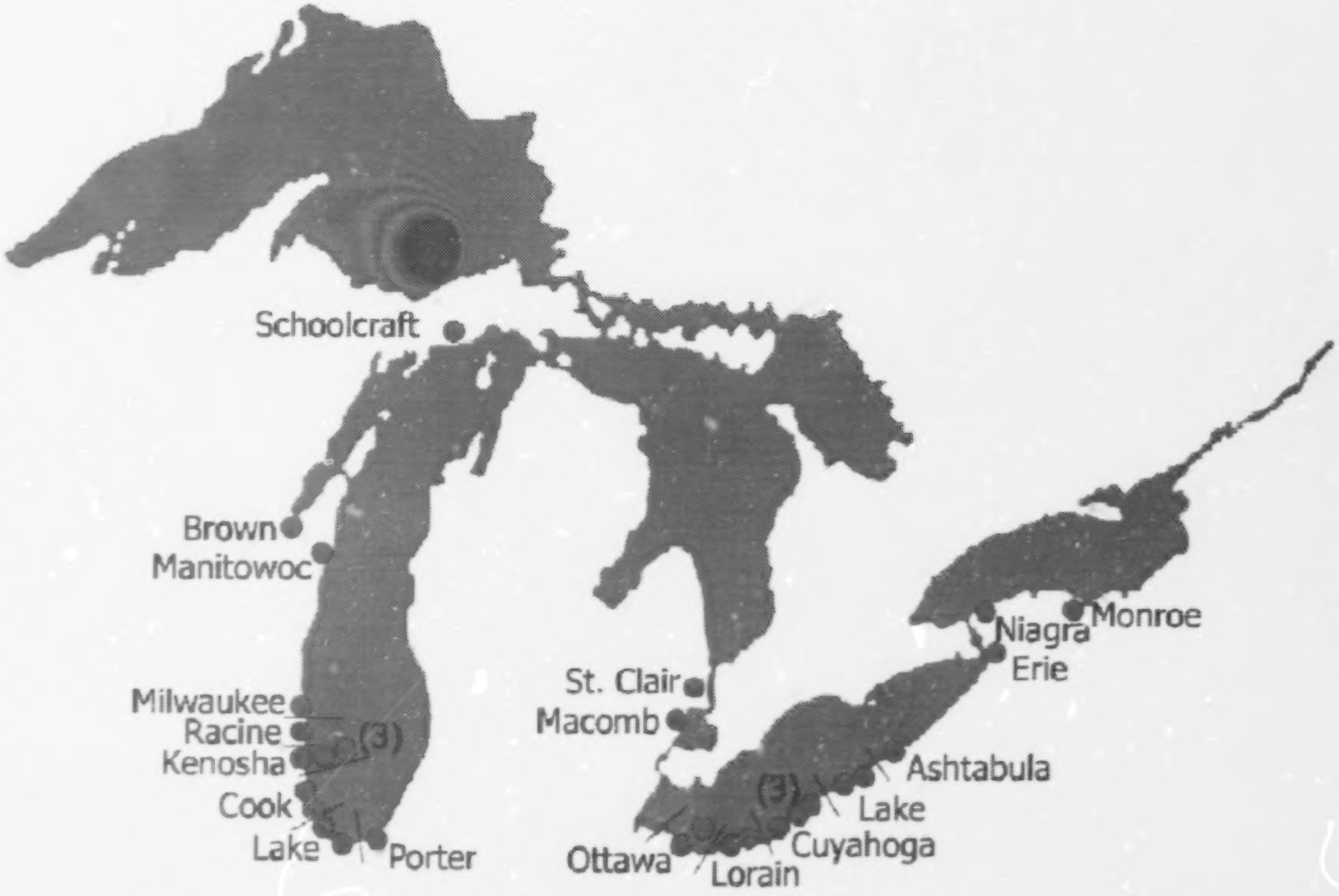
Toronto Point Source Contamination

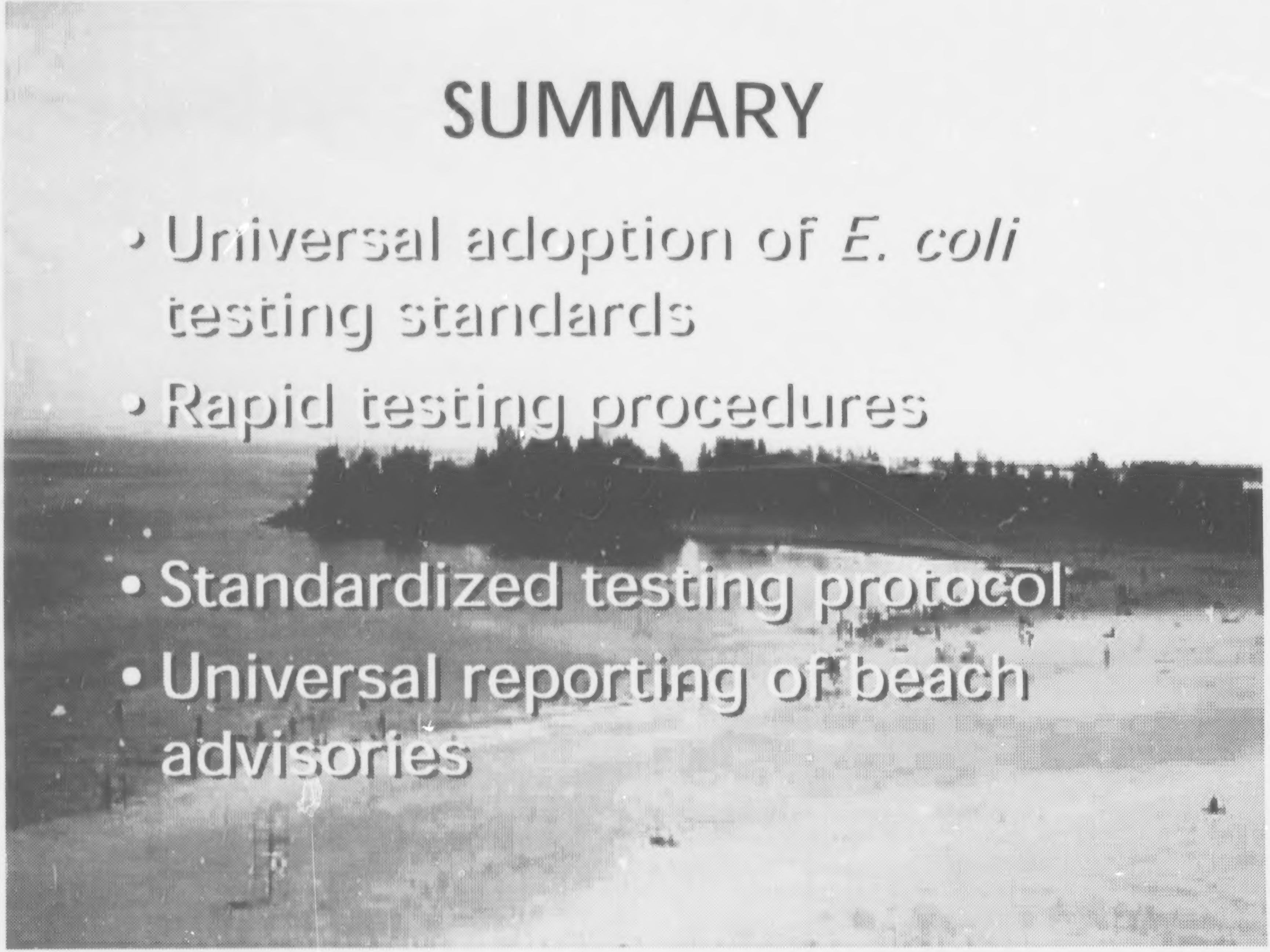
- Identified direct source of contamination nearly eliminating beach advisories
- 2 tunnels installed to intercept/divert runoff from Eastern Beaches
- Western Beaches Tunnel will reduce postings by 75% (under construction)

E. coli at Eastern Toronto Beaches

Summer 1999




Schoolcraft
Brown
Manitowoc
Milwaukee
Racine
Kenosha
(3)
Cook
Lake
Porter
St. Clair
Macomb
Ottawa
Lorain
Cuyahoga
(3)
Lake
Ashtabula
Erie
Niagra
Monroe



SUMMARY

- Universal adoption of *E. coli* testing standards
- Rapid testing procedures
- Standardized testing protocol
- Universal reporting of beach advisories

Conclusion

- The human health indicator for swimming advisories shows a mixed deteriorating state
- However, experience and data tell us that the indicator is mixed improving

Acknowledgments

- **The following contributed data, analysis, or reporting expertise to this indicator:**
  - David Rockwell, Paul Bertram and Wade Jacobson (SEE Program), U.S. Environmental Protection Agency, Great Lakes National Program Office, Chicago, IL
  - Richard Whitman, U.S. Geological Survey, Lake Michigan Ecological Research Station, Porter, IN
  - Marcia Jimenez, City of Chicago Dept. of Environment, Chicago, IL
  - Duncan Boyd and Mary Wilson, Ontario Ministry of Environment, Environmental Monitoring and Reporting Branch, Toronto, Ontario
  - Peter Gauthier, City of Toronto, Environmental Health Services, Toronto, Ontario

Human Health: Drinking Water

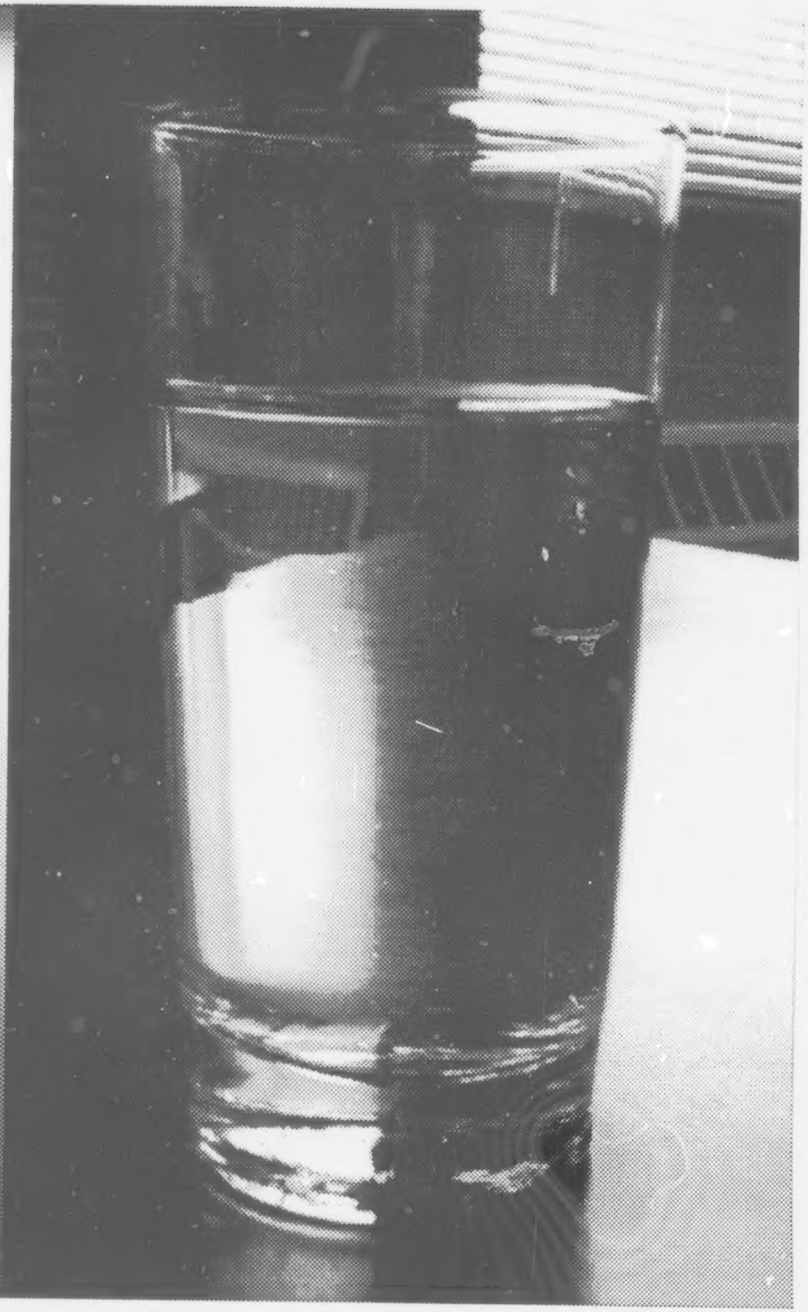
Rod Holme

Past President,

American Water Works Association

SOLEC Objective

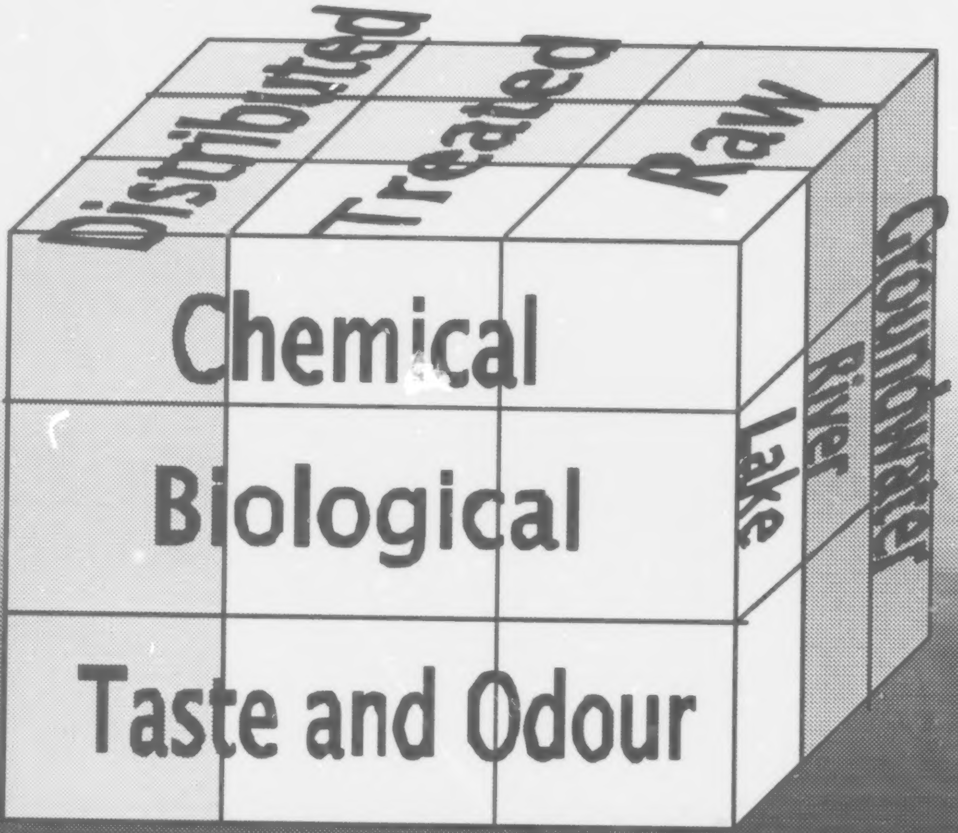
TREATED drinking water supplies should be safe to drink



SOLEC Indicator

Drinking Water Quality features **TRENDS** in chemical and microbial contaminant levels in raw, treated and distributed water

Factors of Drinking Water



Distributed
Treated
Raw

Chemical
Biological
Taste and Odour

Lake
River
Groundwater

Drinking Water Workshop

- Issue is **TREATABILITY**
- U.S. and Ontario policies and regulations provide the minimum standards, guidelines and treatment levels for drinking water

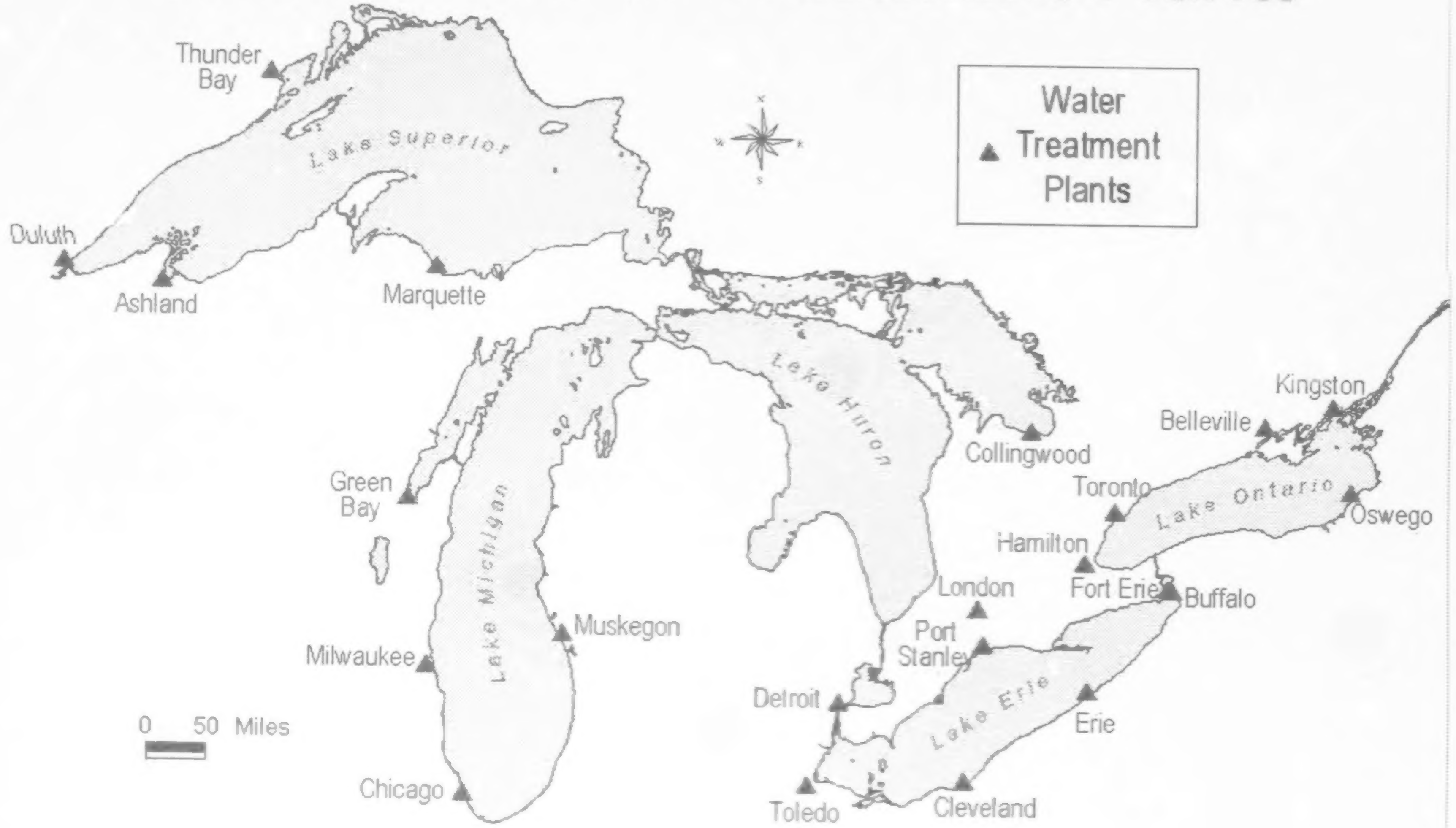
Drinking Water Workshop Conclusions

- The Parties emphasize the need for more attention to the quality of the raw water and the issue of its treatability.
- Greater protection of source water means more reliable treatment

Indicator Measurements

- Suspended Matter as Turbidity
- Organic Matter as Total Organic Carbon (TOC) or Dissolved Organic Carbon (DOC)
- Taste and Odour
- Pathogens
- Chemicals

Selected Water Treatment Plants


Water Treatment Plants
Thunder Bay
Lake Superior
Duluth
Ashland
Marquette
Lake Michigan
Lake Huron
Green Bay
Milwaukee
Muskegon
Chicago
Collingwood
Kingston
Belleville
Toronto
Lake Ontario
Oswego
Hamilton
London
Fort Erie
Buffalo
Port Stanley
Detroit
Lake Erie
Erie
Toledo
Cleveland
0 50 Miles
N
E
S
W

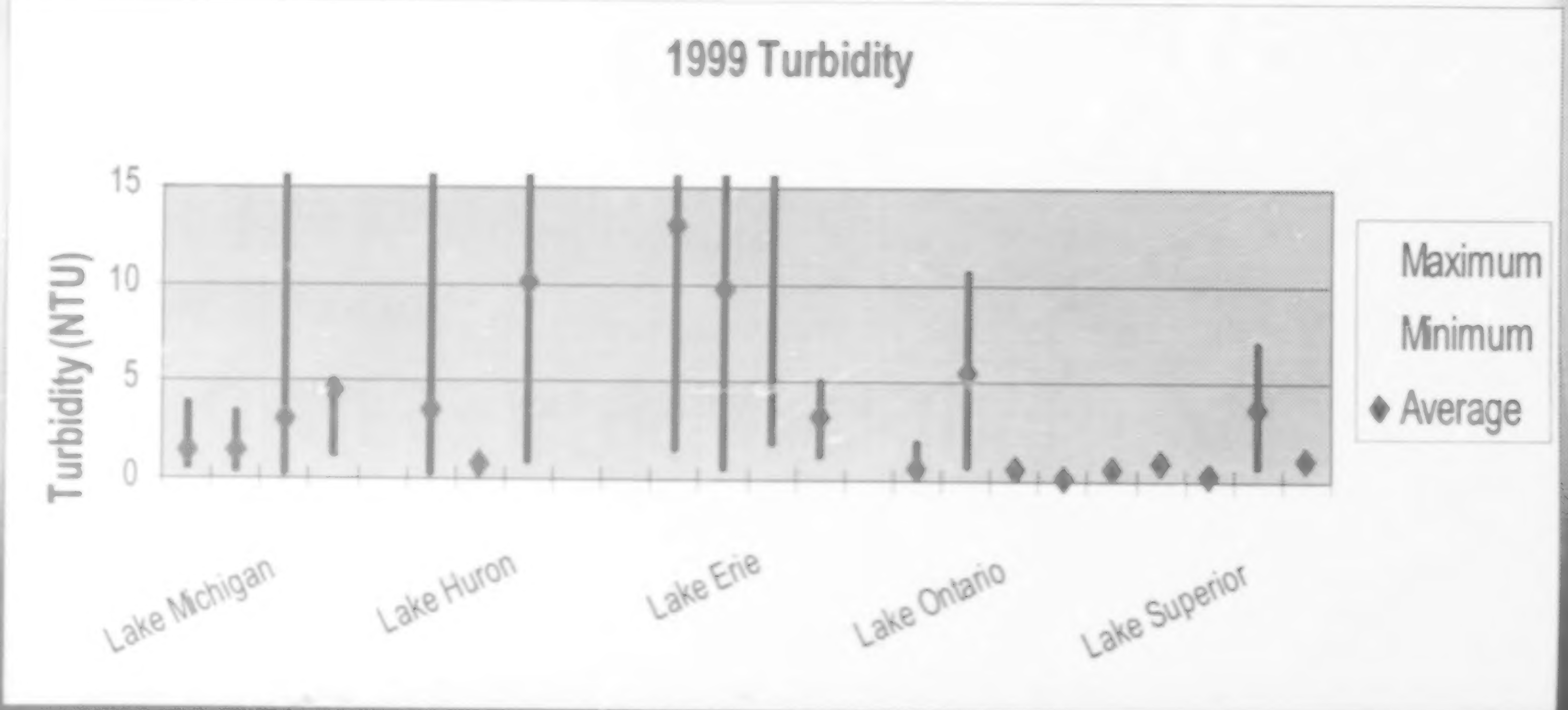
Turbidity

- Data are widely available in raw and treated water
- Raw water data are site specific
- Simple, continuously available measurement

Turbidity as an Indicator

- SOLEC measurement "local trends or deviations from baseline"
- Strong relationship between turbidity and health related parameters

1999 Turbidity Fluctuations



Turbidity Results

- Source water turbidity fluctuates both by season and location
- Treated water turbidity is very low

Organic Matter

- Total Organic Carbon (TOC) data for U.S. sites
- Dissolved Organic Carbon (DOC) data for Canadian sites

Organic Carbon as an Indicator

Increased organic carbon is linked to an increase in disinfection by-products and potential for carcinogenic compounds

Organic Carbon Results

- Raw water levels at these sites are almost always better than treated water standard
- Not a problem in Great Lakes

Taste and Odour

- Aesthetic parameter
- Important indicator for consumers
- "Inoffensive" is objective

Taste and Odour as an Indicator

- Difficult to quantify scientifically due to variety of gauging methods
- Related to presence of algae
- Methods for measurement include taste and odour panels, threshold odour, and Geosmin/MIB (2-methylisoborneol) tests

Taste and Odour Results

- Increasing problem over last 3 years
- Numerous consumer complaints
- Clearer water, higher temperatures
- More studies initiated to quantify problem agents like MIB/Geosmin

Pathogens

- Total Coliform
- *E. coli*
- Giardia
- Cryptosporidium

Pathogens as an Indicator

- Total Coliform is most frequent measurement
  - Usually present in raw water
  - Always measured in treated water
- *E. coli* testing not routinely performed in raw water

Pathogens as an Indicator, Continued

- Low risk for Giardia & Cryptosporidium in Great Lakes raw water unless intake is directly influenced by onshore sources
- Present methods for Giardia and Cryptosporidium are not as reliable

Pathogen Results

- 2 sites exceeded standards in 10 years for treated water from US Safe Drinking Water Information System
- Ontario Drinking Water Surveillance Program did not exceed standards through 1996
- Similar results in municipal data
- Low pathogen presence for these 22 sites

Chemicals

- Atrazine
- Nitrate
- Nitrite

Atrazine and Nitrogen as Indicators

- Atrazine
  - One source is herbicide application
- Nitrate and nitrite
  - Sources can be fertilizer runoff and septic tank leaching

Chemicals

- Atrazine
  - Raw water levels better than required minimum for treated
- Nitrate/Nitrite
  - Raw water levels better than required minimum for treated

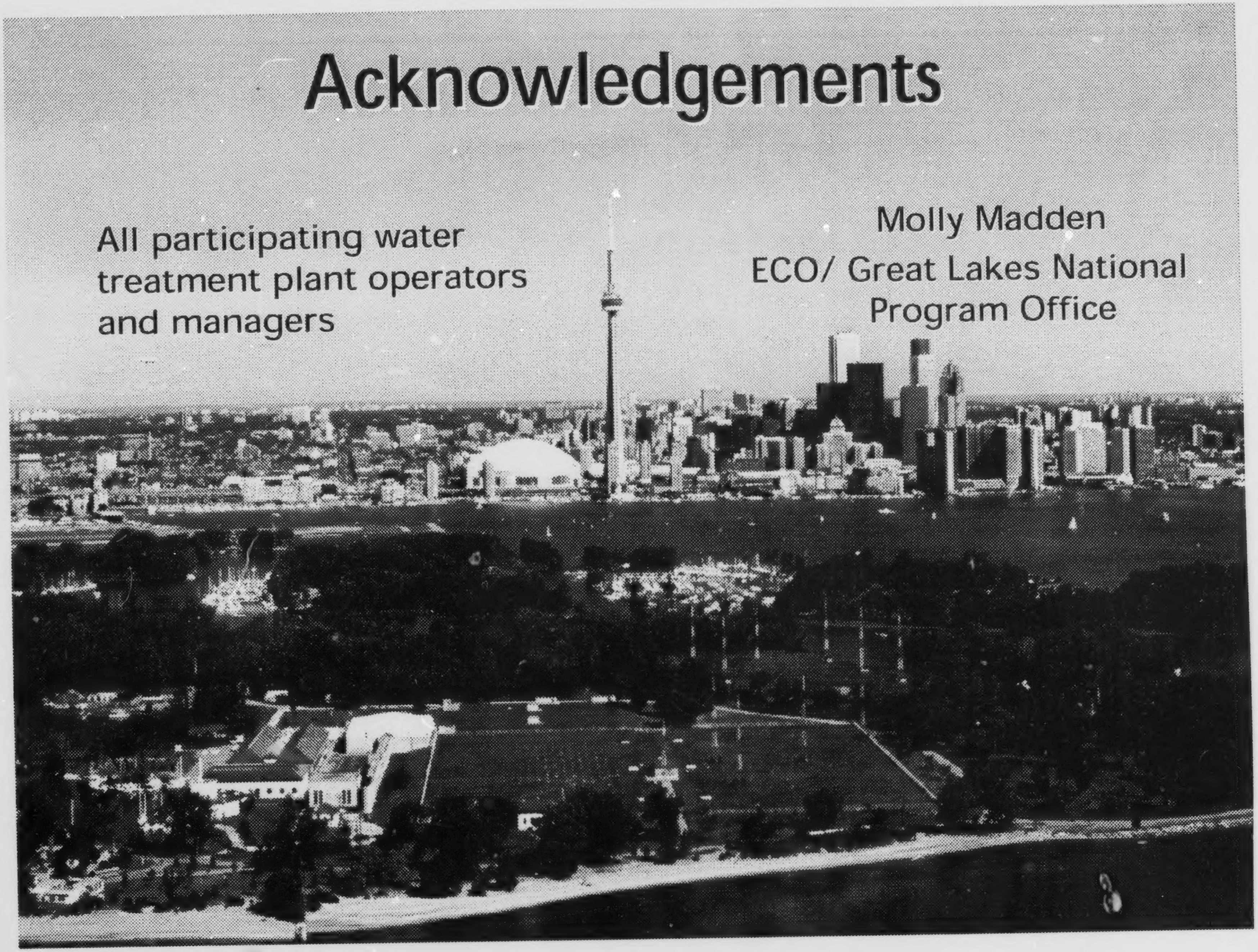
Existing Pressures

- Non-point sources
- Increased algae presence and increased temperatures producing "offensive" taste or odour
- Balance between disinfection by-products and microbial protection
- Aging distribution systems
- Research
- Consumer Confidence

Conclusions

- State of drinking water at these 22 sites is good
- Source water protection needs to be promoted
- Lack of uniformity in data prevents comprehensive comparisons
- Consumer Confidence Reports provide comprehensive data

Acknowledgements



All participating water treatment plant operators and managers

Molly Madden
ECO/ Great Lakes National Program Office

Human Health -
Fish Contaminants Indicator

Patricia McCann

Minnesota Department of Health

Human Health -
Fish Contaminants Indicator

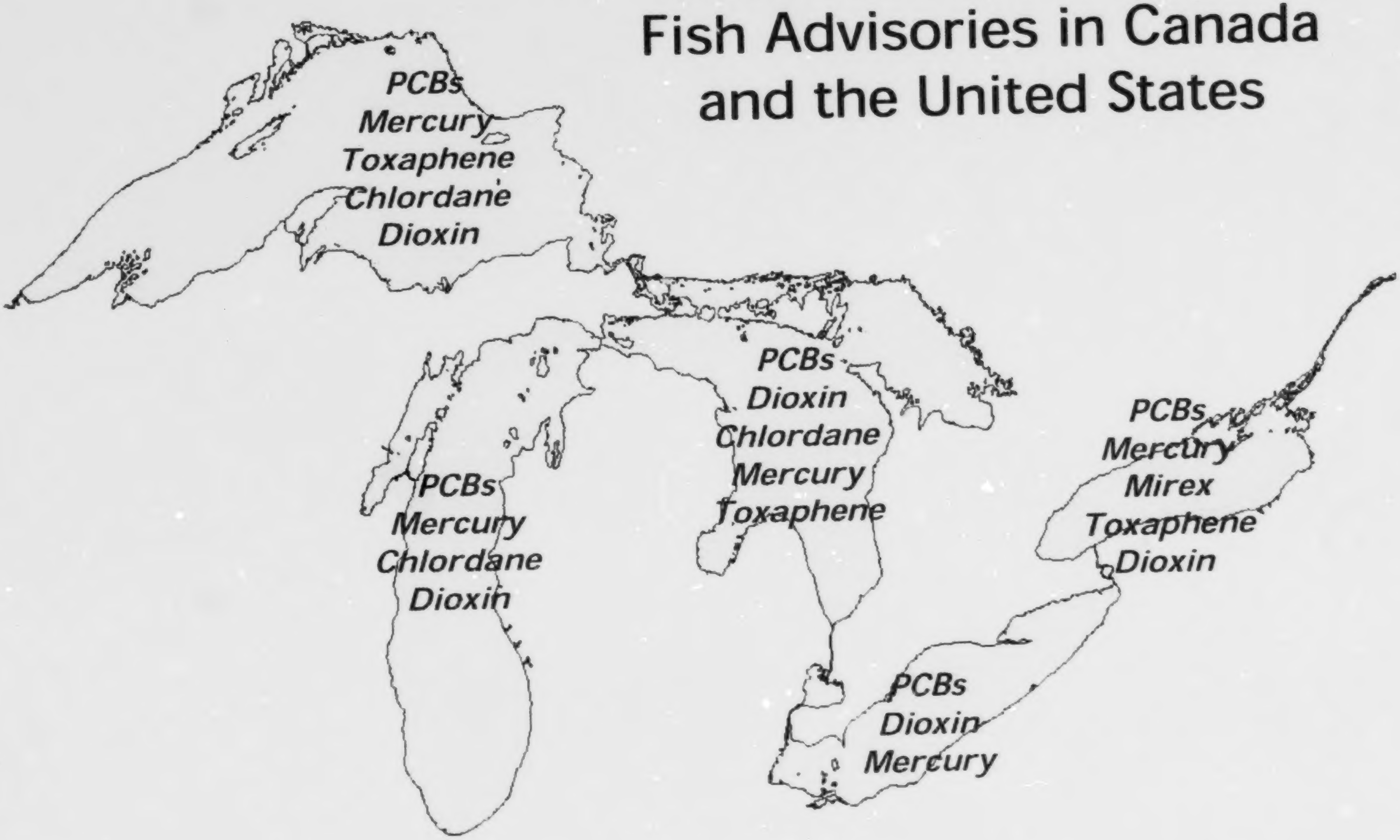
What causes changes in Fish Consumption Advice?

- Contaminant levels
- Interpretation of safe dose

What is NOT an indicator of the "edibility" of fish?

- Number of fish advisories
- Total lake area or river miles under an advisory
- "Green" areas

Contaminants that Cause Fish Advisories in Canada and the United States


PCBs
Mercury
Toxaphene
Chlordane
Dioxin
PCBs
Dioxin
Chlordane
Mercury
Toxaphene
PCBs
Mercury
Chlordane
Dioxin
PCBs
Mercury
Mirex
Toxaphene
Dioxin
PCBs
Dioxin
Mercury

Human Health -
Fish Contaminants Indicator

- A standardized method for calculating consumption advice
- Historical data on contaminants in fish

A Starting Point

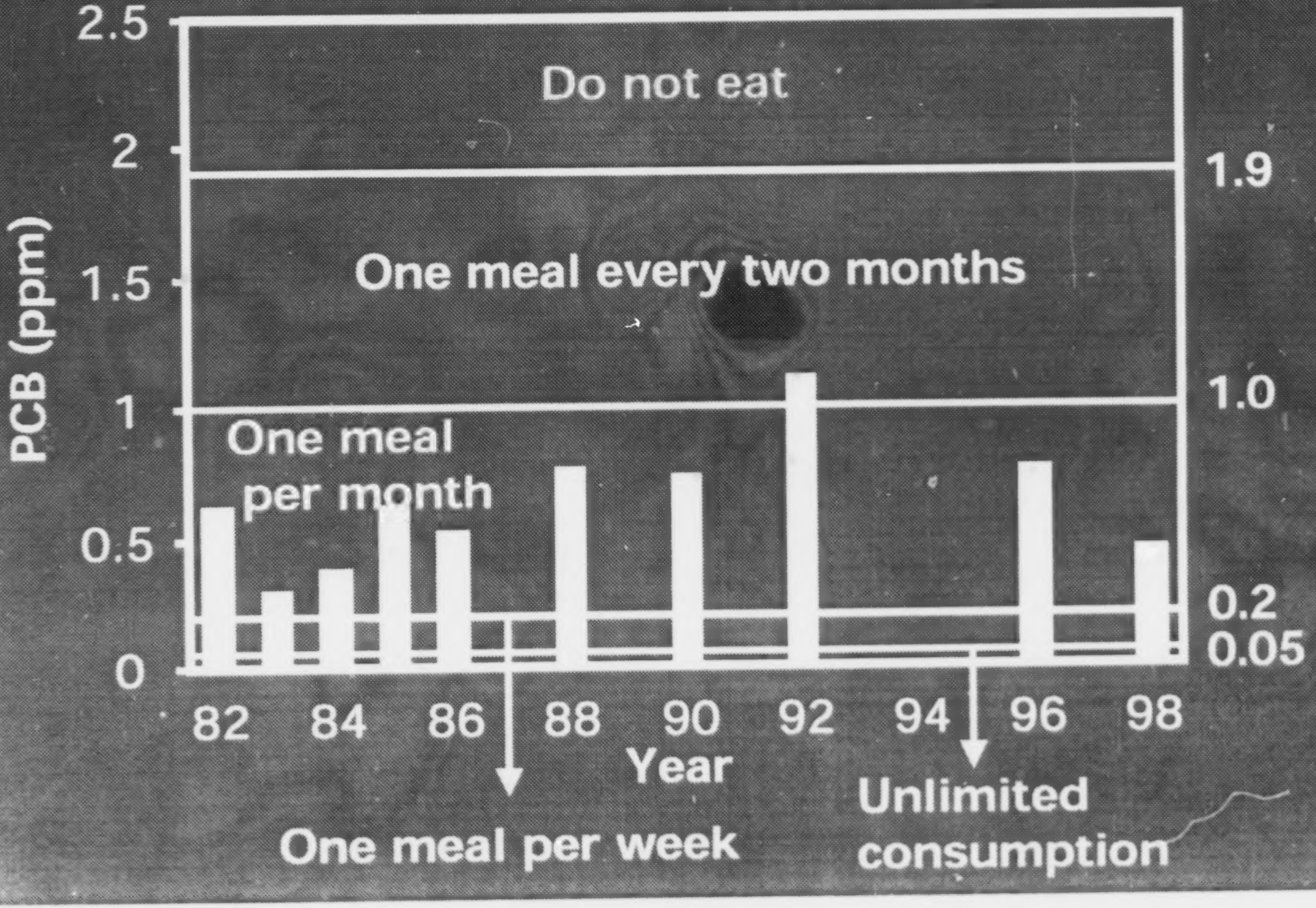
- Protocol for Uniform Great Lakes Sport Fish Consumption Advisory for PCBs

- Data from:
  - US EPA GLNPO Great Lakes Fish Monitoring Program
  - Ontario MOE Sport Fish Contaminant Monitoring Program

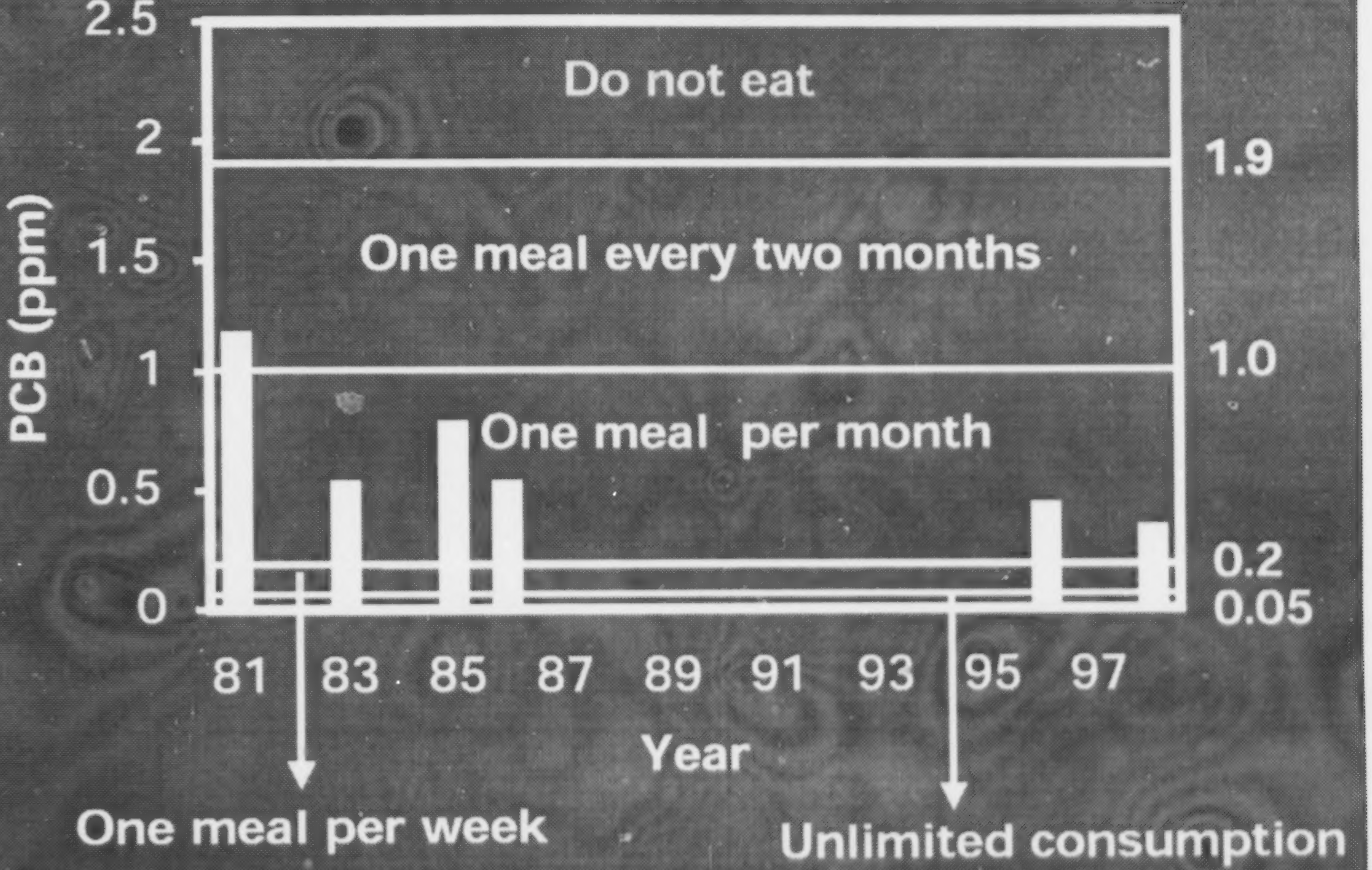
Protocol for Uniform Great Lakes Sport Fish Consumption Advisory

Meal Frequency	PCB concentration (ppm)
Unlimited	< 0.05
1 meal/week	0.06 – 0.2
1 meal/month	0.21 – 1.0
meal/2-month	1.1 – 1.9
Do not eat	> 1.9

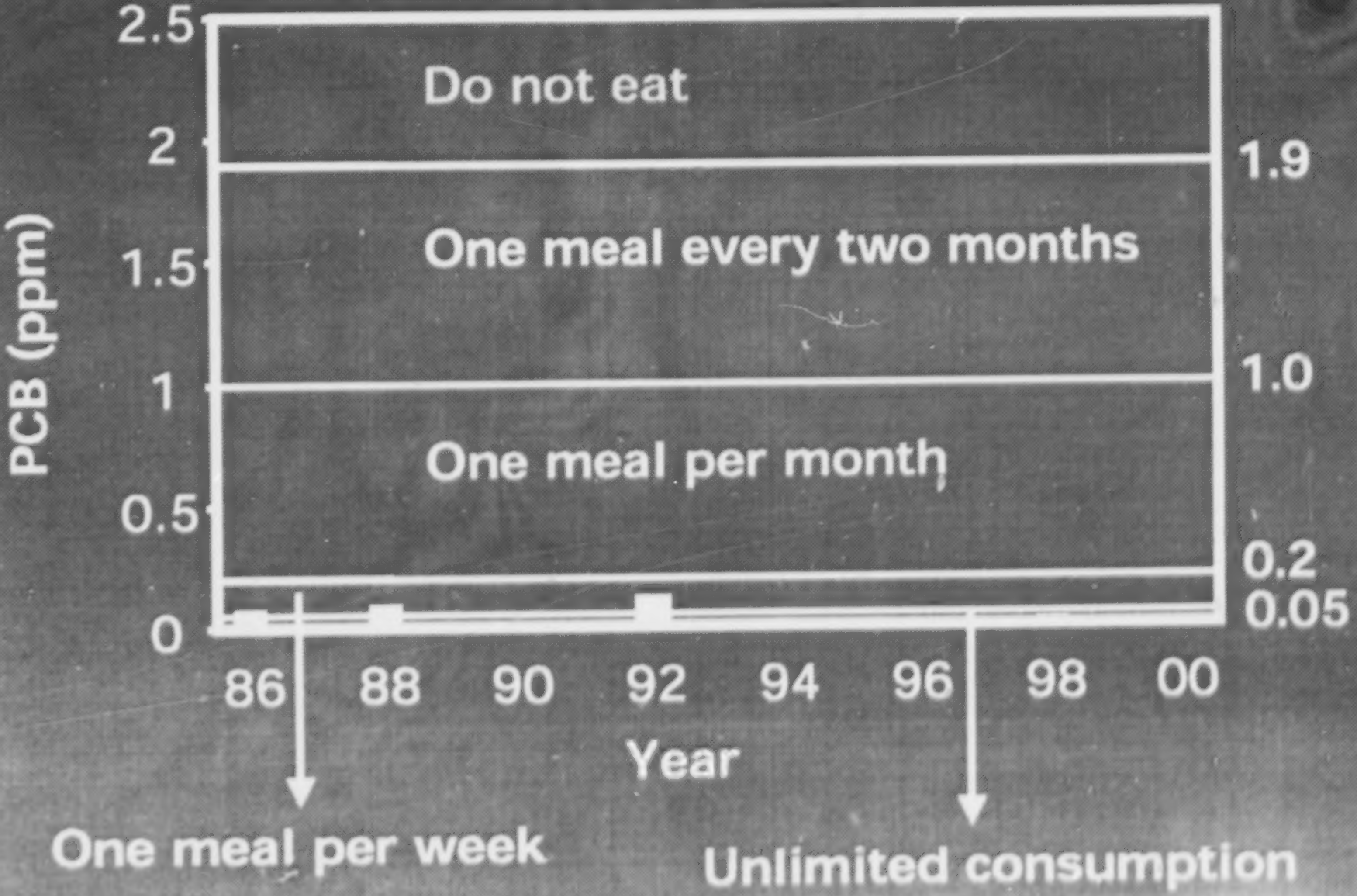
PCBs in Lake Michigan Coho Salmon



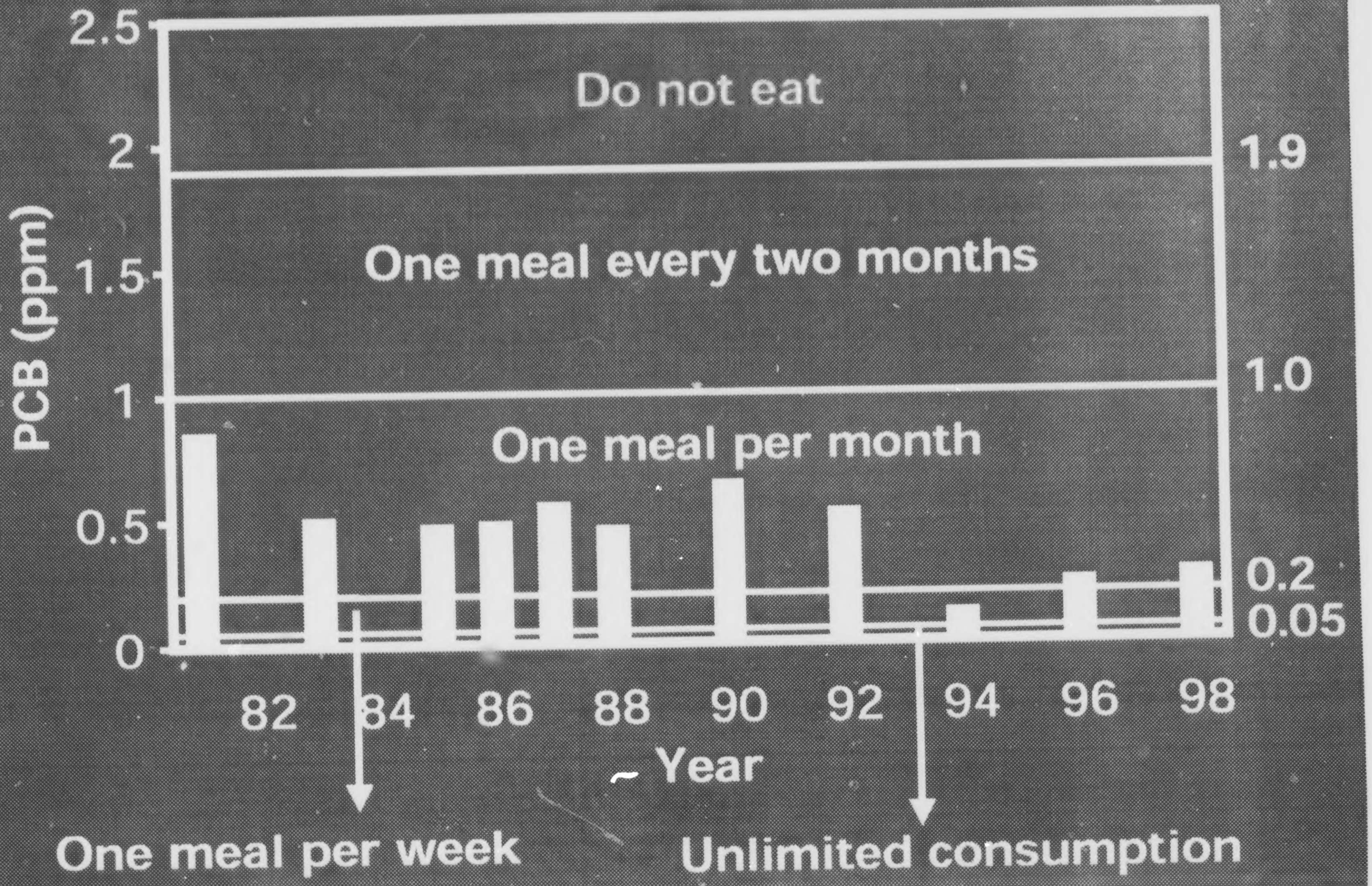
PCBs in Lake Huron Coho Salmon



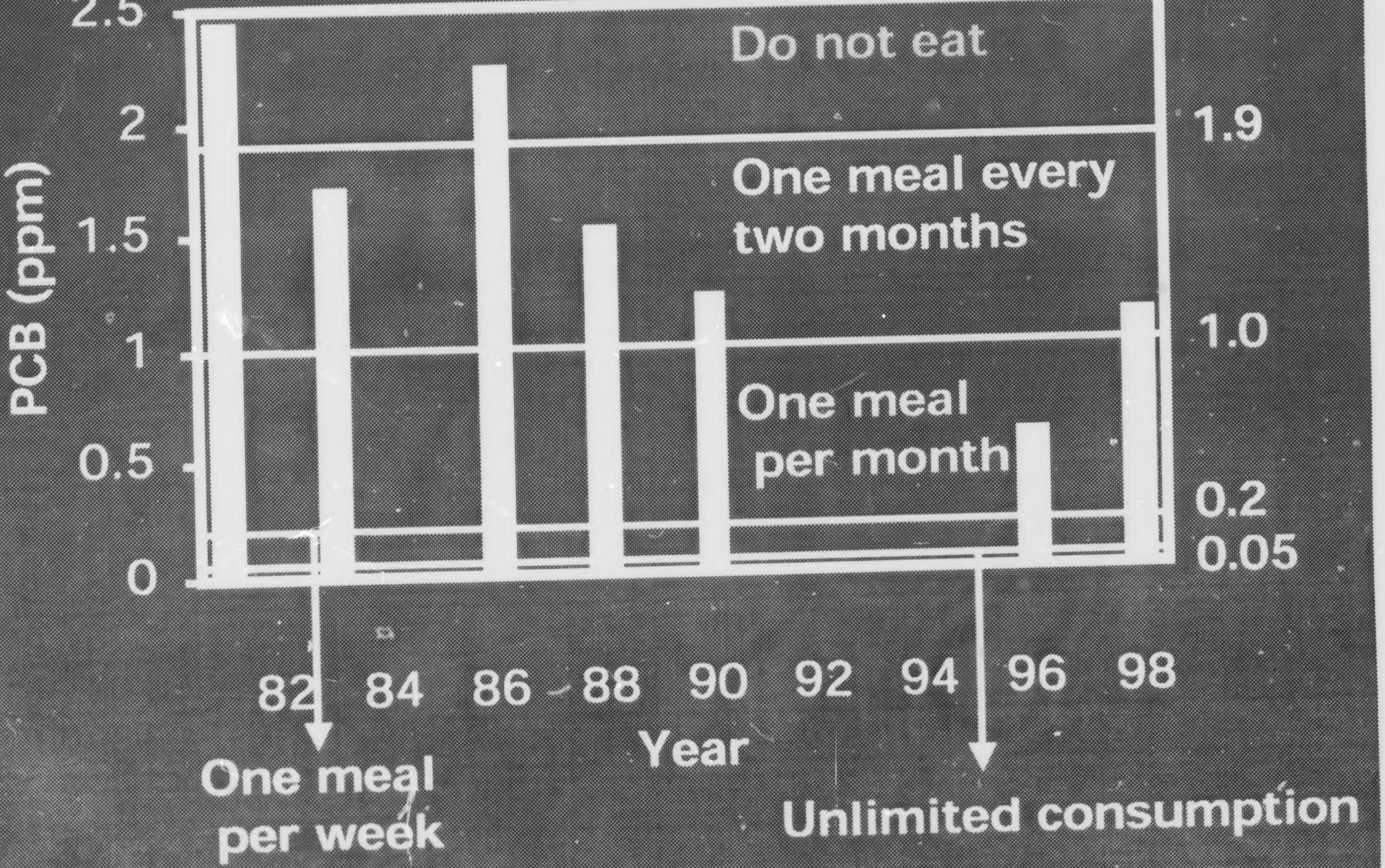
PCBs in Lake Superior Coho Salmon



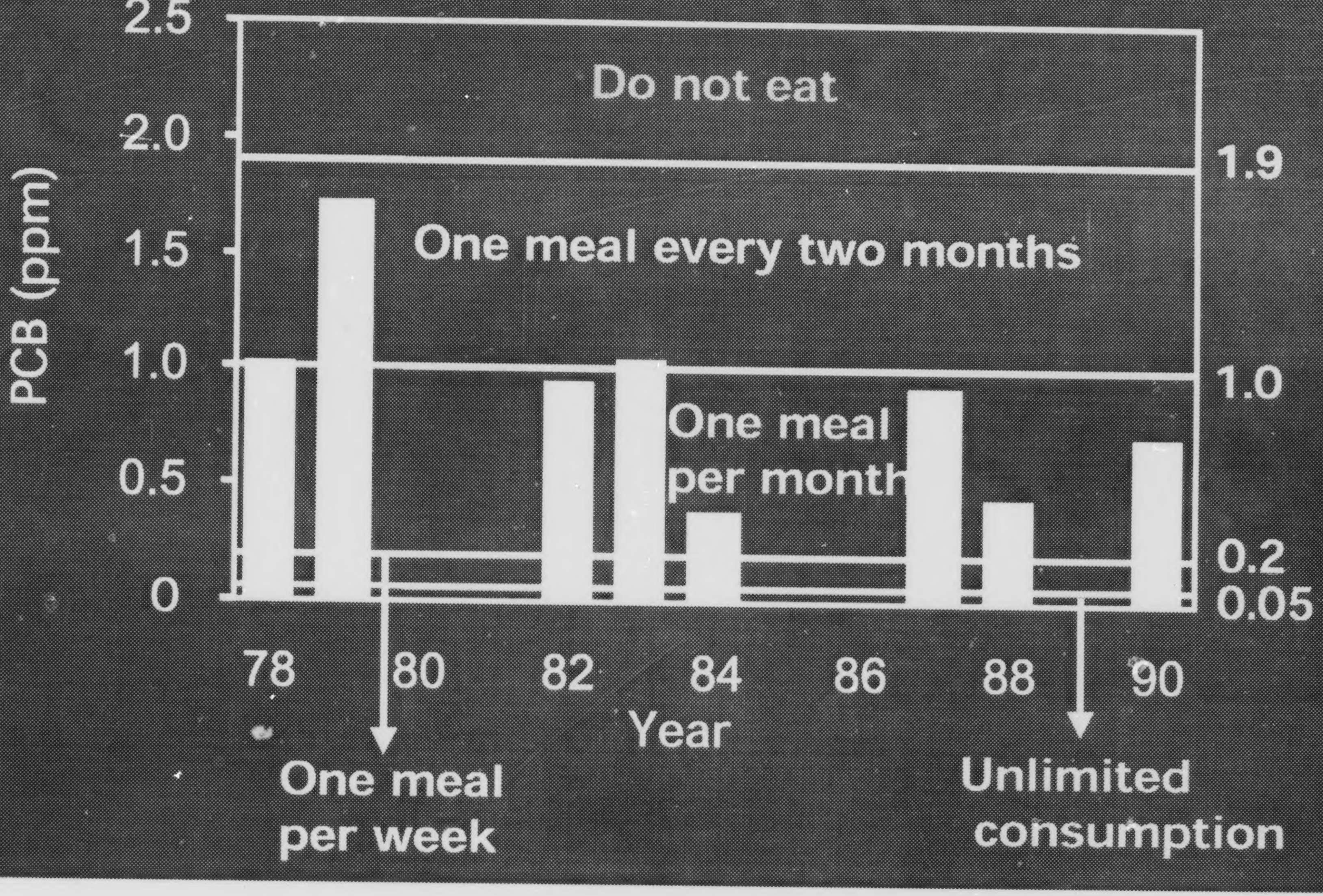
PCBs in Lake Erie Coho Salmon



PCBs in Lake Ontario Coho Salmon



PCBs in Western Lake Ontario Coho Salmon

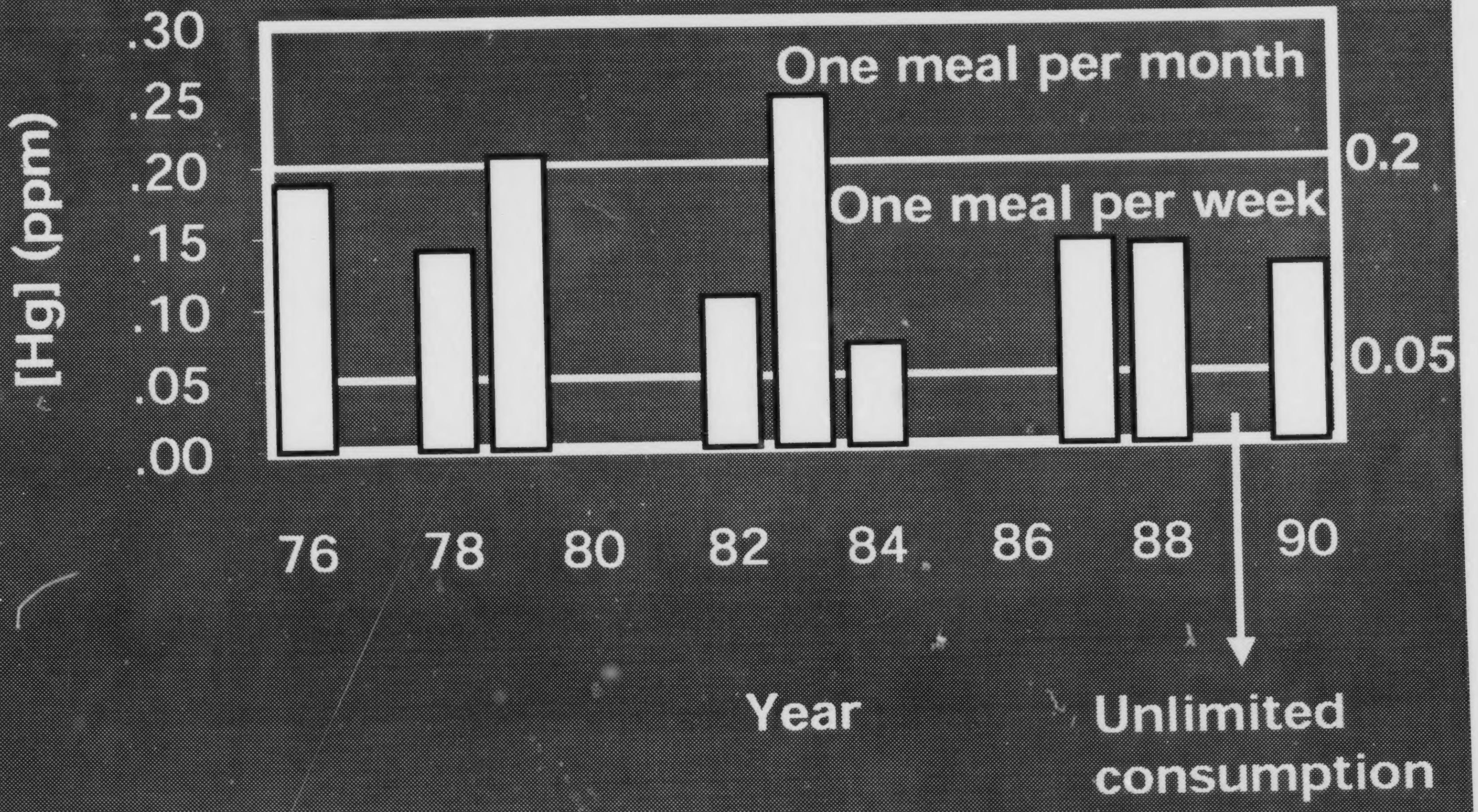


PCB-based Meal Advice for Coho

- Superior - 1 meal/week
- Erie, Huron, Michigan
  - 1 meal/month
- Ontario
  - 1 meal/2-months → 1 meal/month

- Large concentration changes needed to change advice

Western Lake Ontario
Coho Salmon



Next Steps

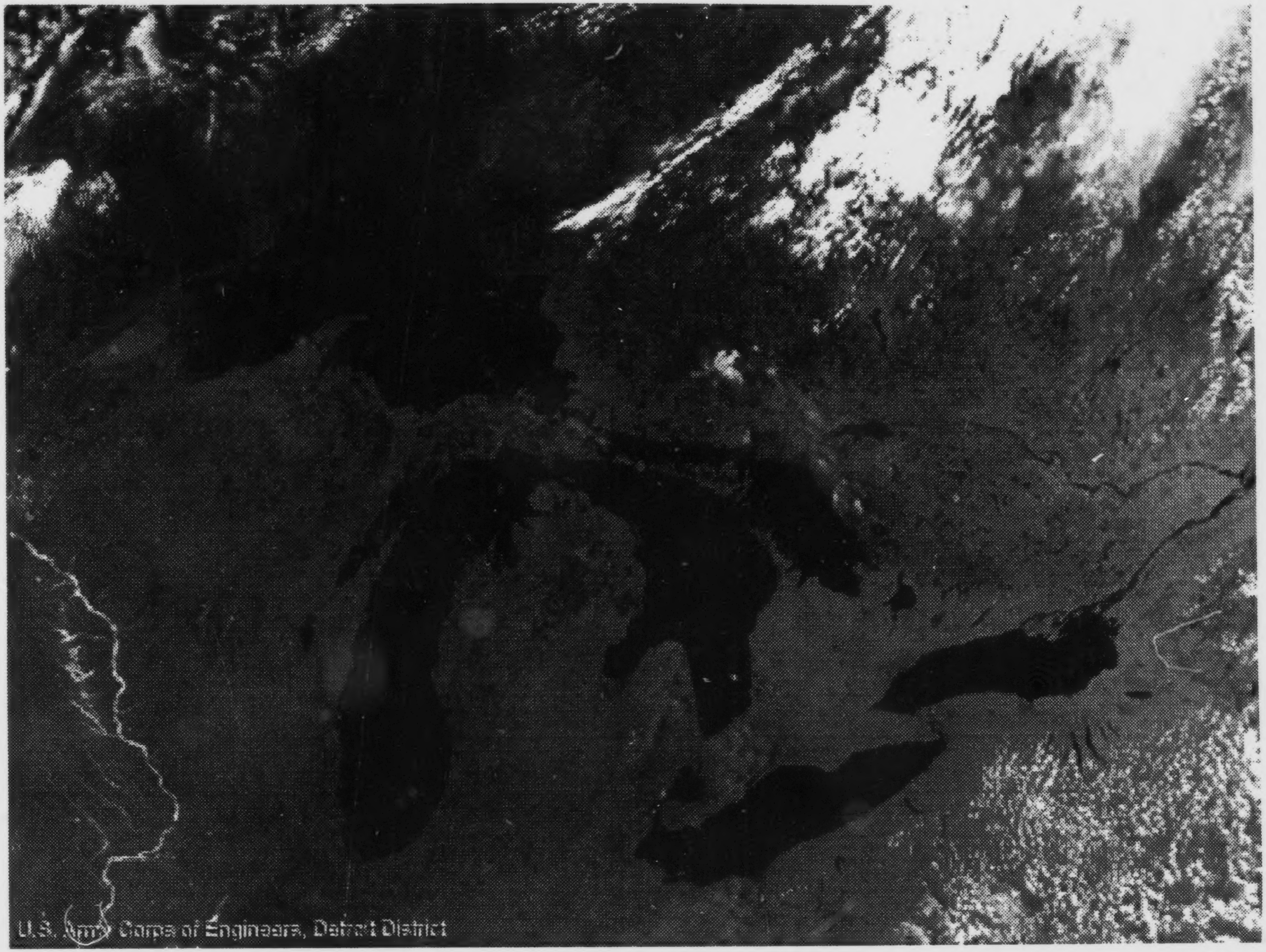
- Promote data coordination
  - explore relationships in existing datasets
  - future monitoring parameters
- Work towards agreement on standardized advisory protocols
- Expand indicator to other chemicals
- Expand indicator to other species
- Pilot project

Contributors

- Great Lakes National Program Office
- Ontario Ministry of the Environment
- Department of Fisheries and Oceans
- Great Lakes States Sport Fish Advisory Taskforce
- Great Lakes Indian Fish and Wildlife Commission

Great Lakes Indices: A Concept for Discussion

Paul Bertram
US EPA
Great Lakes National Program Office



U.S. Army Corps of Engineers, Detroit District

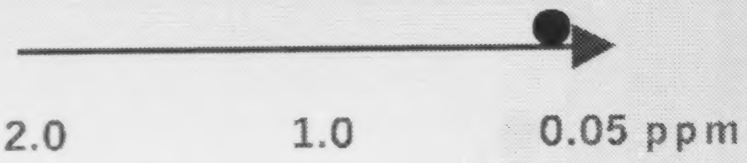
Concept of Great Lakes Indices

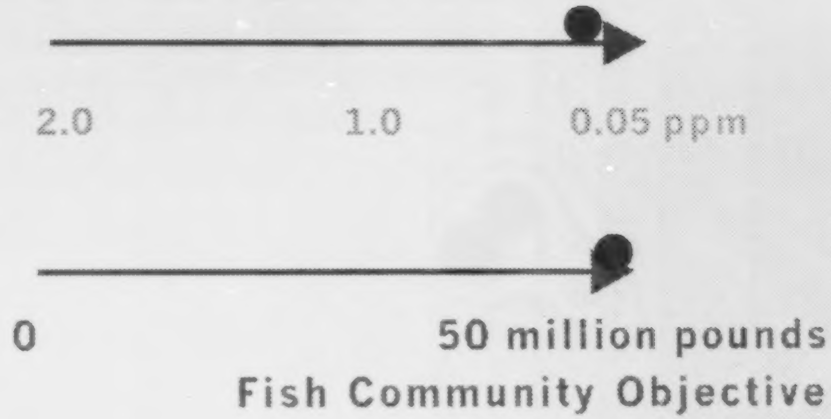
- Consolidate several indicators into an index
- Look at related indicators together
- Provide simplified assessment of environmental conditions
- Simple numeric scale
- Visual cue

Great Lakes Indicator Example: Walleye in Lake Erie

- Contaminants in edible fish tissue
- Abundance or yield
- Preyfish
- Habitat Availability

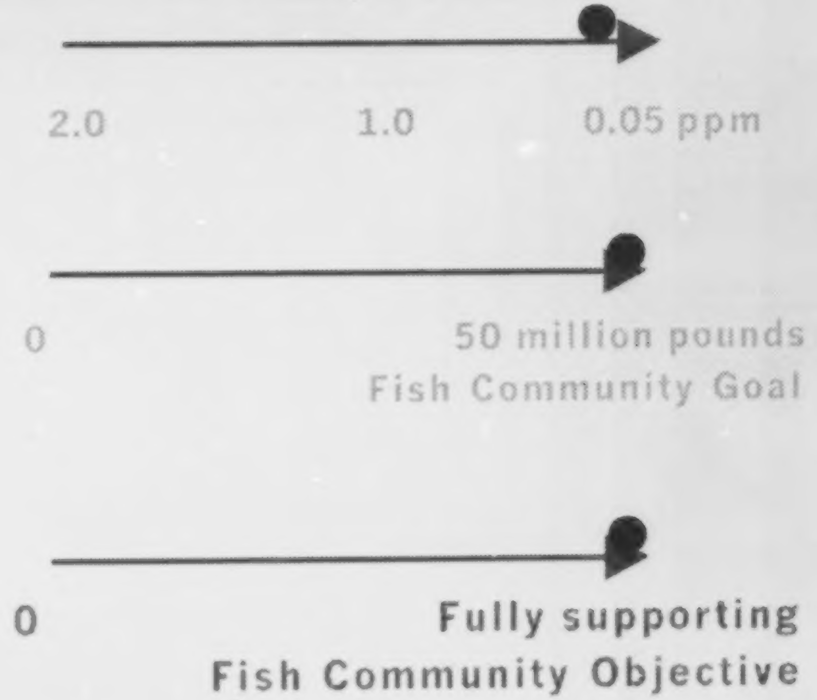
Contaminant Concentration in Edible Fish Tissue


2.0
1.0
0.05 ppm


2.0
1.0
0.05 ppm
0
50 million pounds
Fish Community Objective

Contaminant Concentration
in Edible Fish Tissue

Annual abundance/ yield



Contaminant Concentration
in Edible Fish Tissue

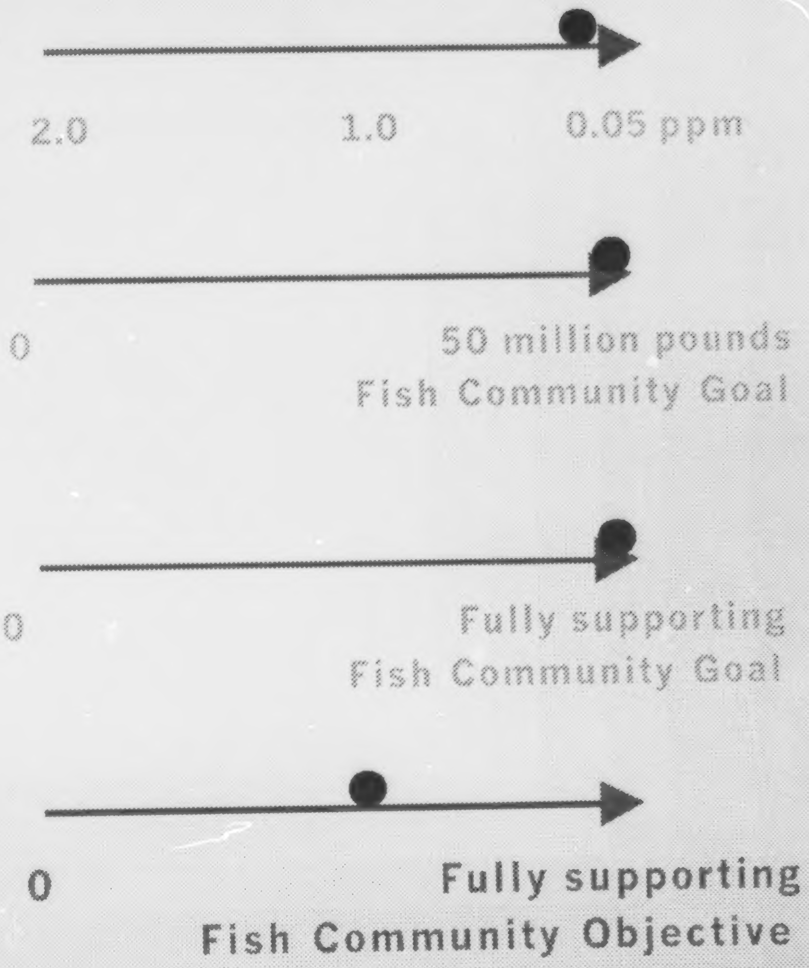
2.0 1.0 0.05 ppm

Annual abundance/ yield

0 50 million pounds
Fish Community Goal

Prey Fish

0 **Fully supporting**
Fish Community Objective



Contaminant Concentration in Edible Fish Tissue

2.0 1.0 0.05 ppm

Annual abundance/ yield

0

50 million pounds
Fish Community Goal

Prey Fish

0

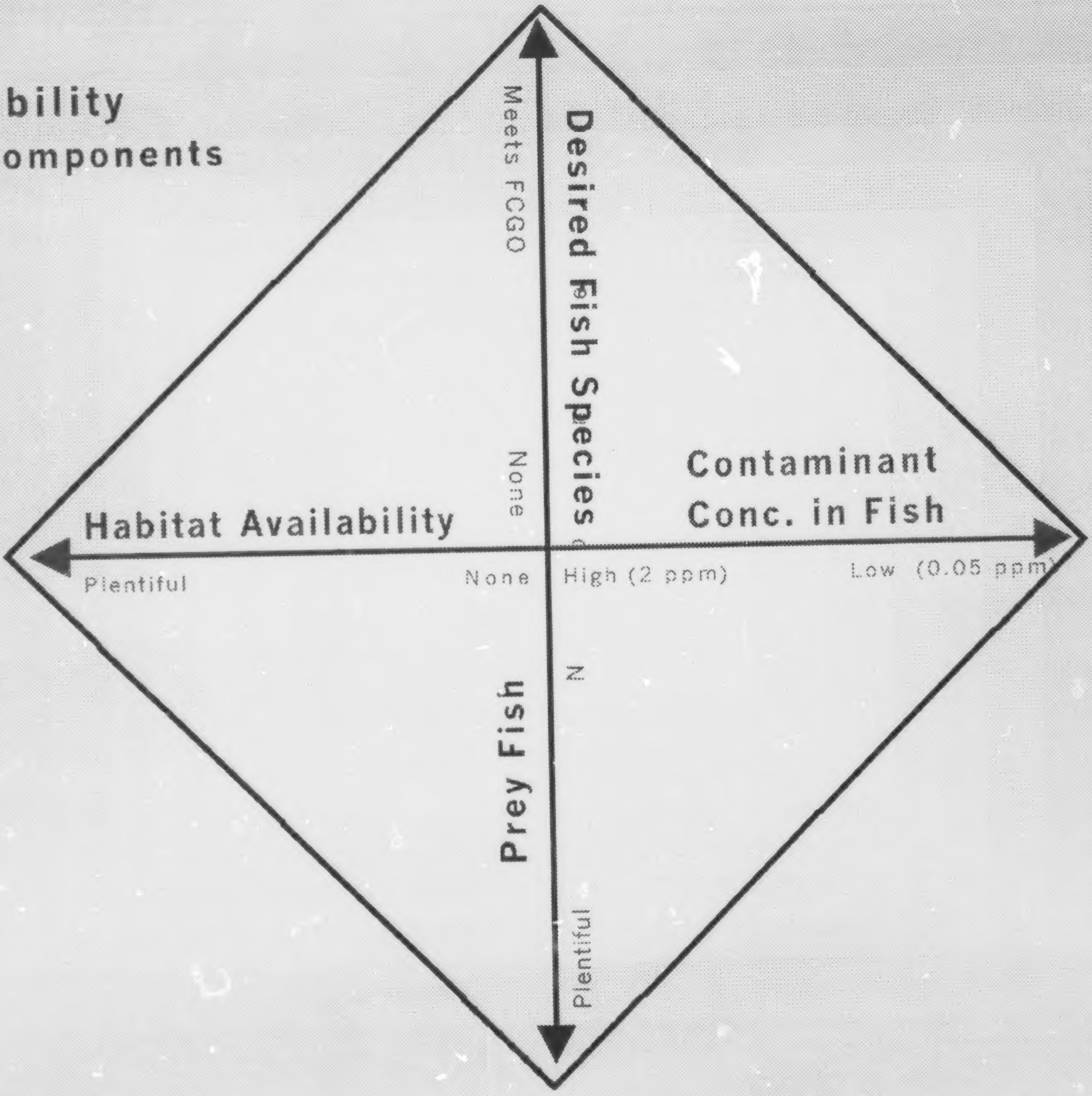
Fully supporting
Fish Community Goal

Habitat

0

Fully supporting
Fish Community Objective

Fishability
Key Components



Desired Fish Species
Meets FCGO
None

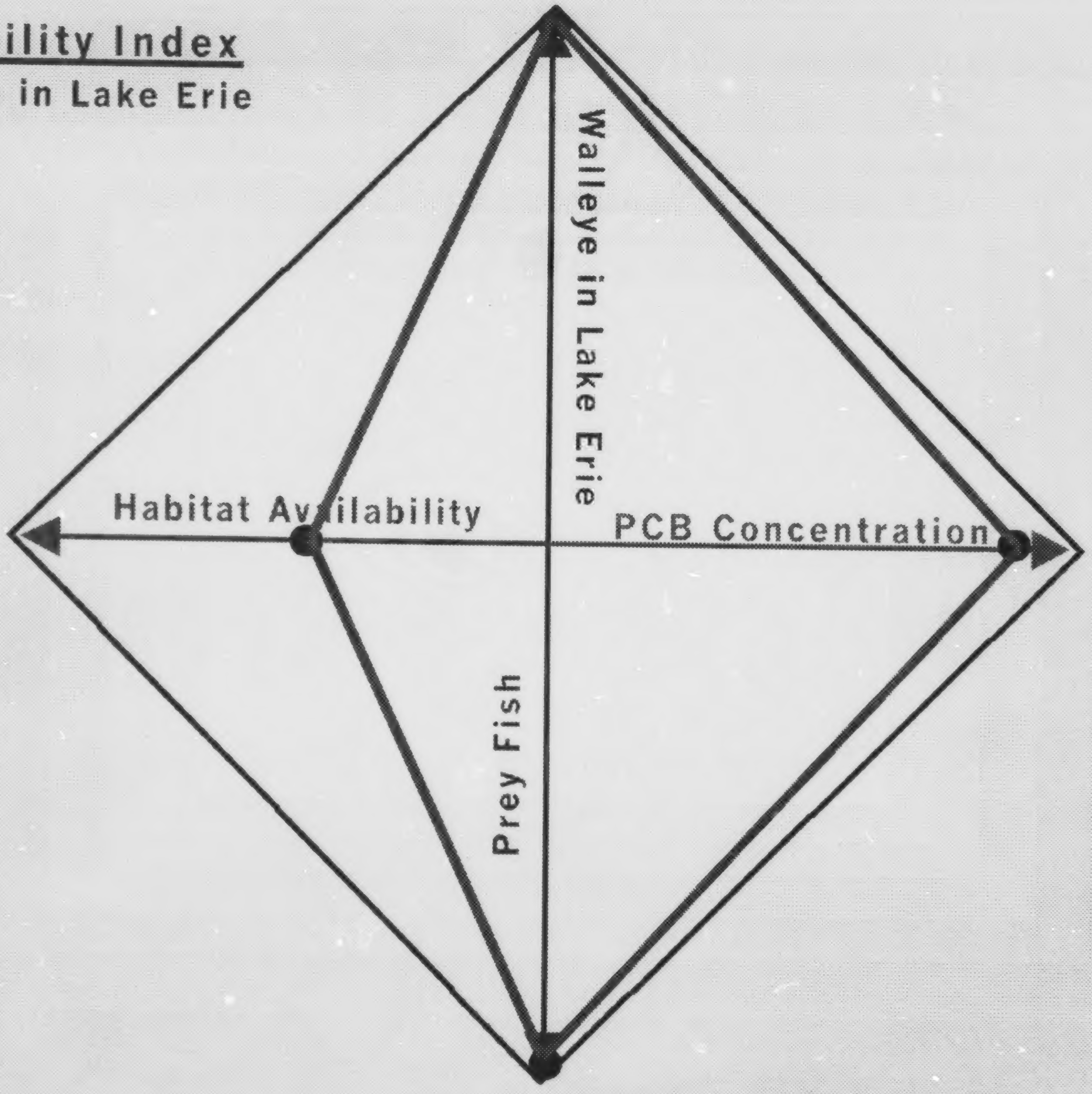
Contaminant
Conc. in Fish
High (2 ppm)
Low (0.05 ppm)

Habitat Availability
Plentiful
None

Prey Fish
N
Plentiful

Fishability Index

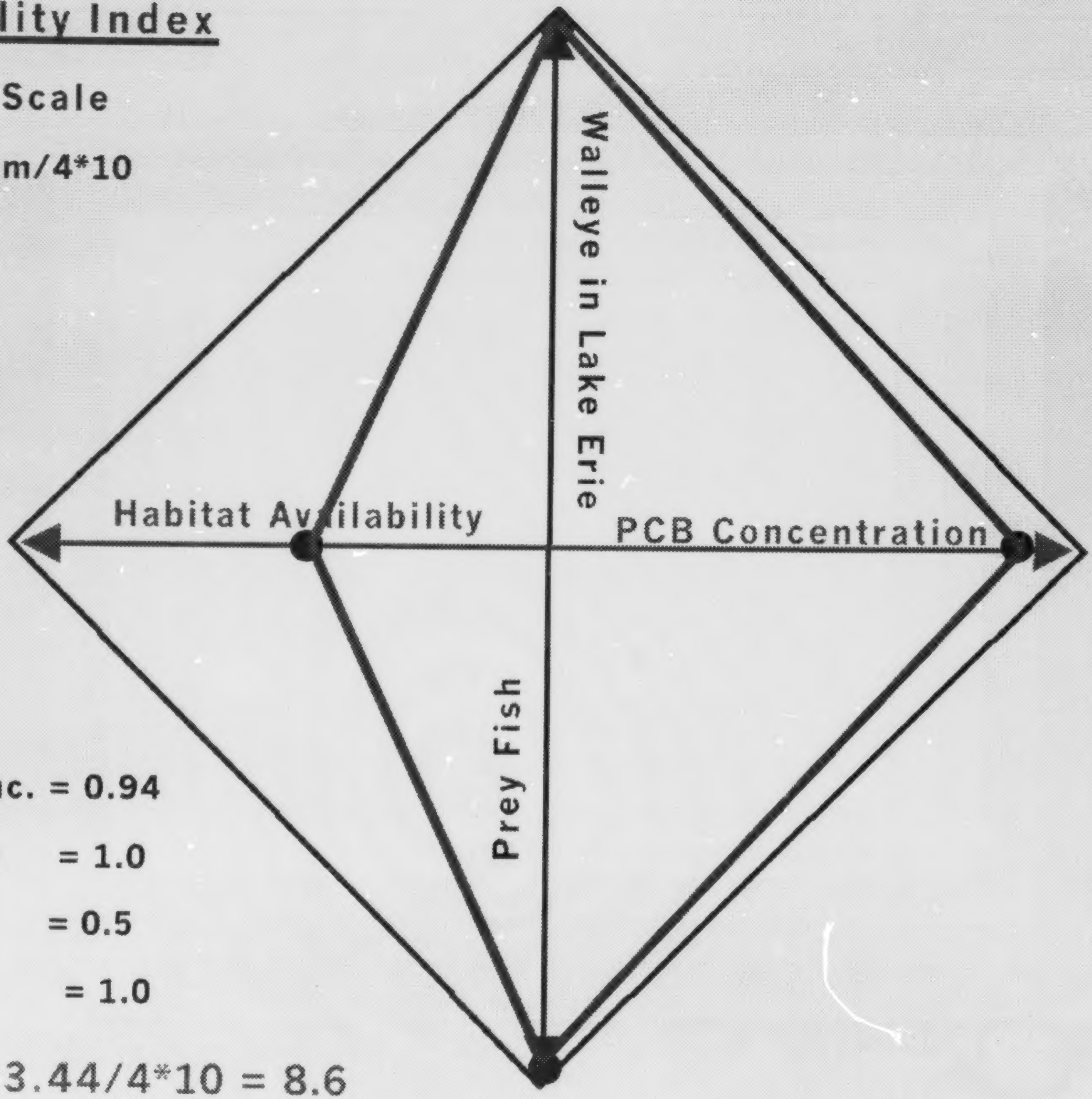
Walleye in Lake Erie


Walleye in Lake Erie
Habitat Availability
PCB Concentration
Prey Fish

Fishability Index

Average Scale

Index = sum/4*10


Walleye in Lake Erie
Habitat Availability
PCB Concentration
Prey Fish

Example

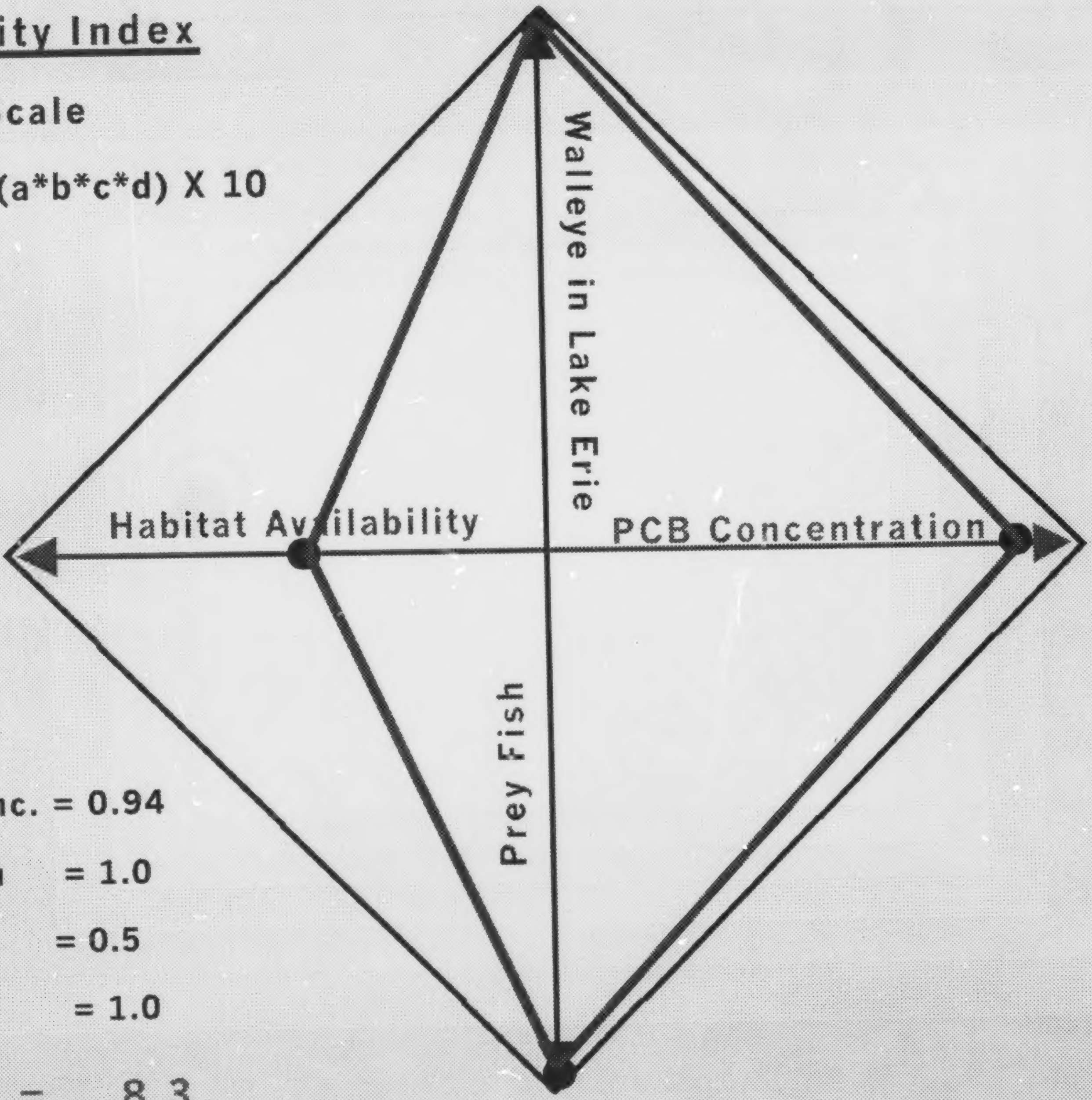
Cont. conc. = 0.94
Prey Fish = 1.0
Habitat = 0.5
Fish Sp. = 1.0

Index = 3.44/4*10 = 8.6

Fishability Index

Product Scale

Index = $\sqrt[4]{(a*b*c*d)}$ X 10

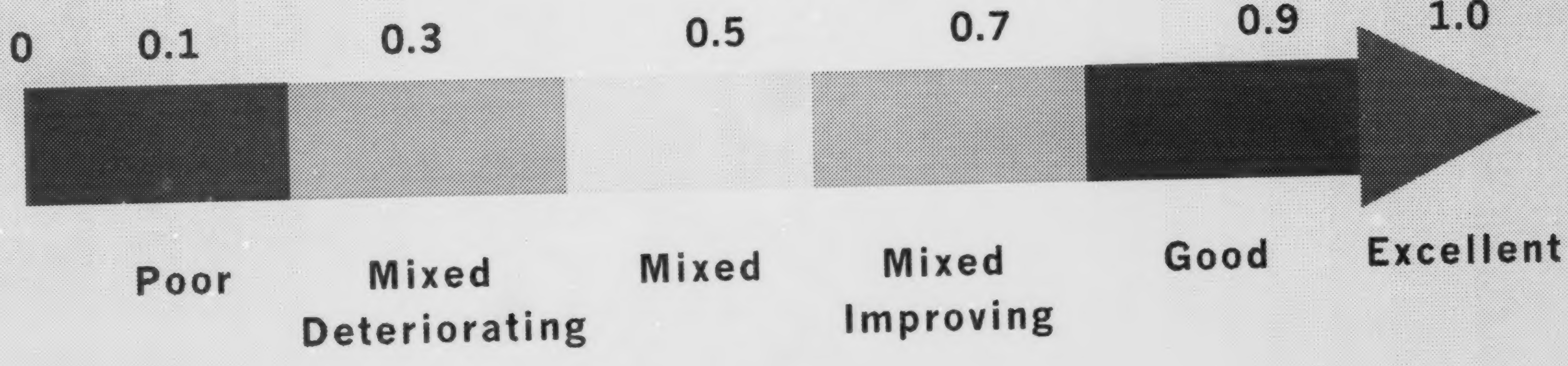

Walleye in Lake Erie
Habitat Availability
PCB Concentration
Prey Fish

Example

Cont. conc. = 0.94
Prey Fish = 1.0
Habitat = 0.5
Fish Sp. = 1.0

Index = 8.3

Index Scale for Qualitative Ratings



0 0.1 0.3 0.5 0.7 0.9 1.0

Poor

Mixed
Deteriorating

Mixed

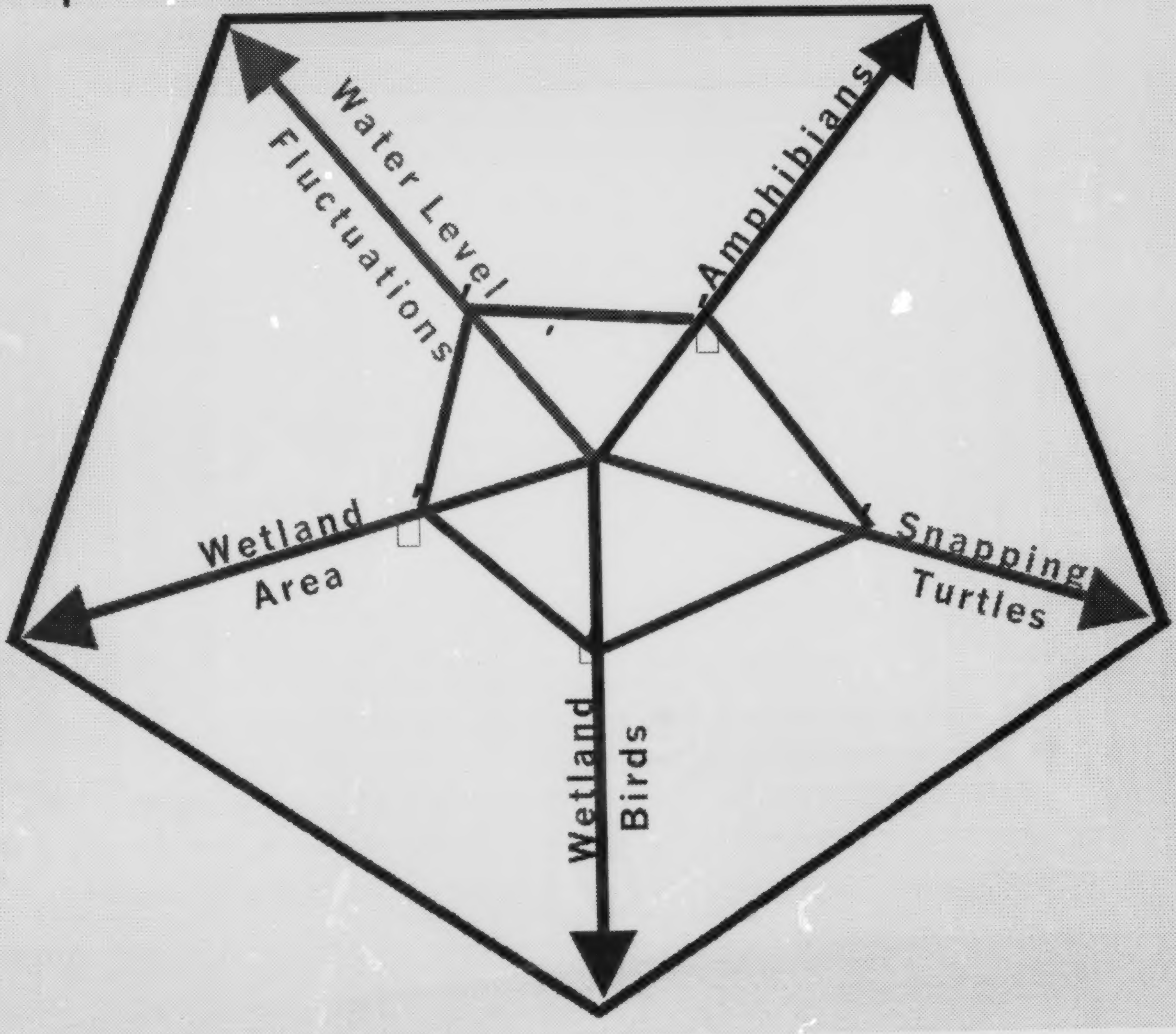
Mixed
Improving

Good

Excellent

Wetlands

Key Components



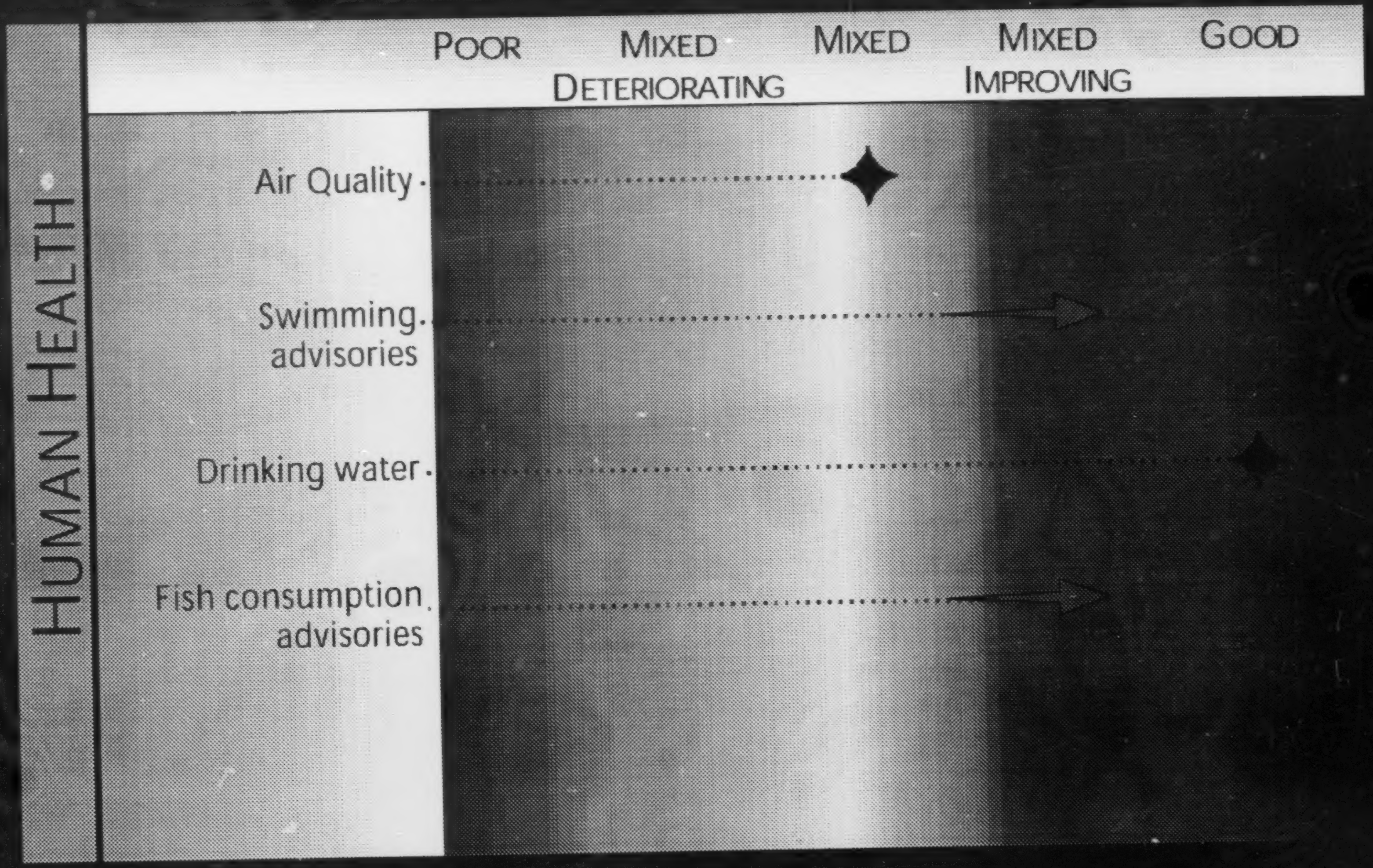
Great Lakes Indices
Questions for Discussion

- Is an index approach useful?
  - For managers?
  - For the public?
- What features should be in an index?
  - Numerical score?
  - Visual cue?
  - Others?
- What indicator groupings make sense?

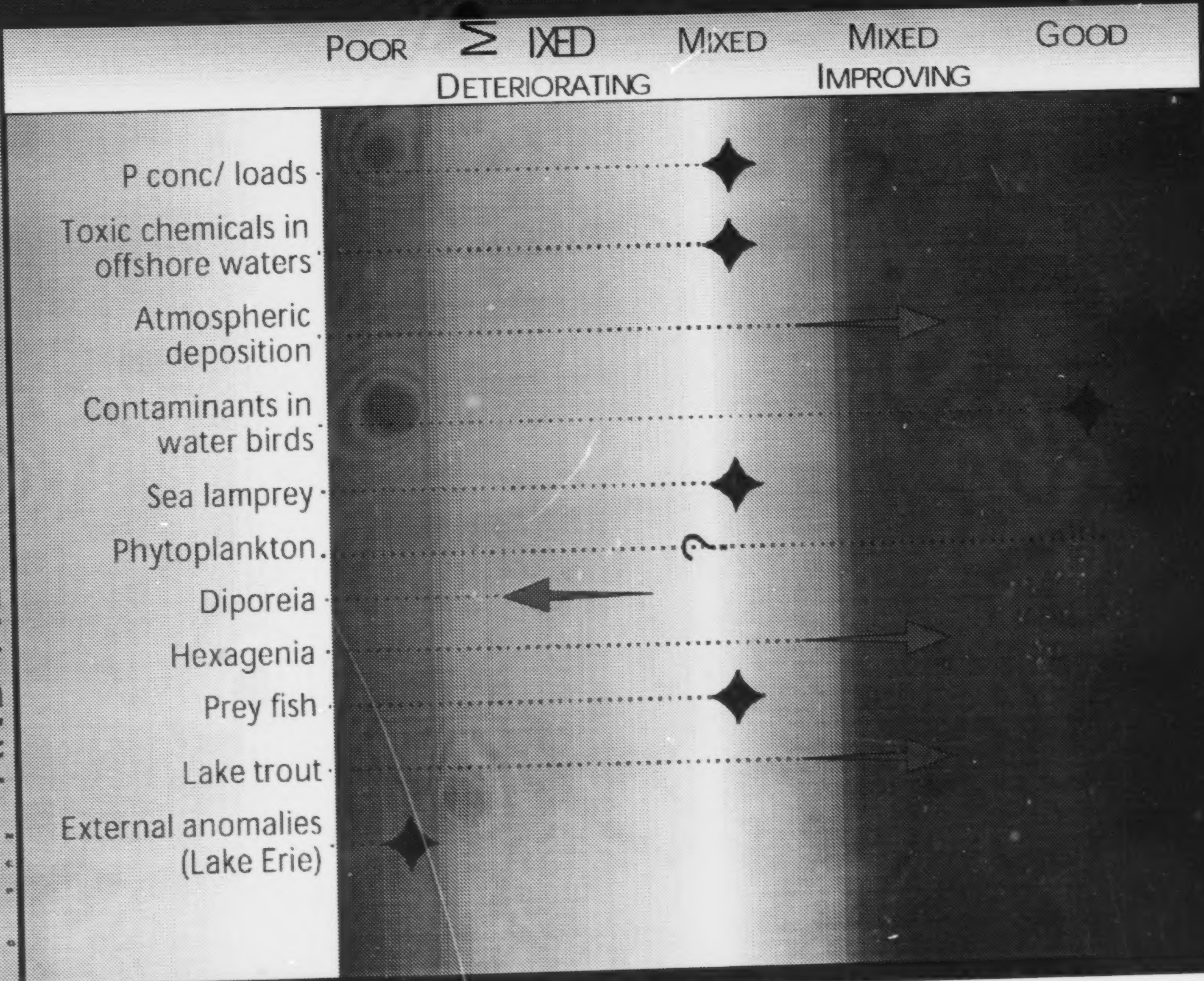
SUMMARY AND CHARGE

Kelly Burch

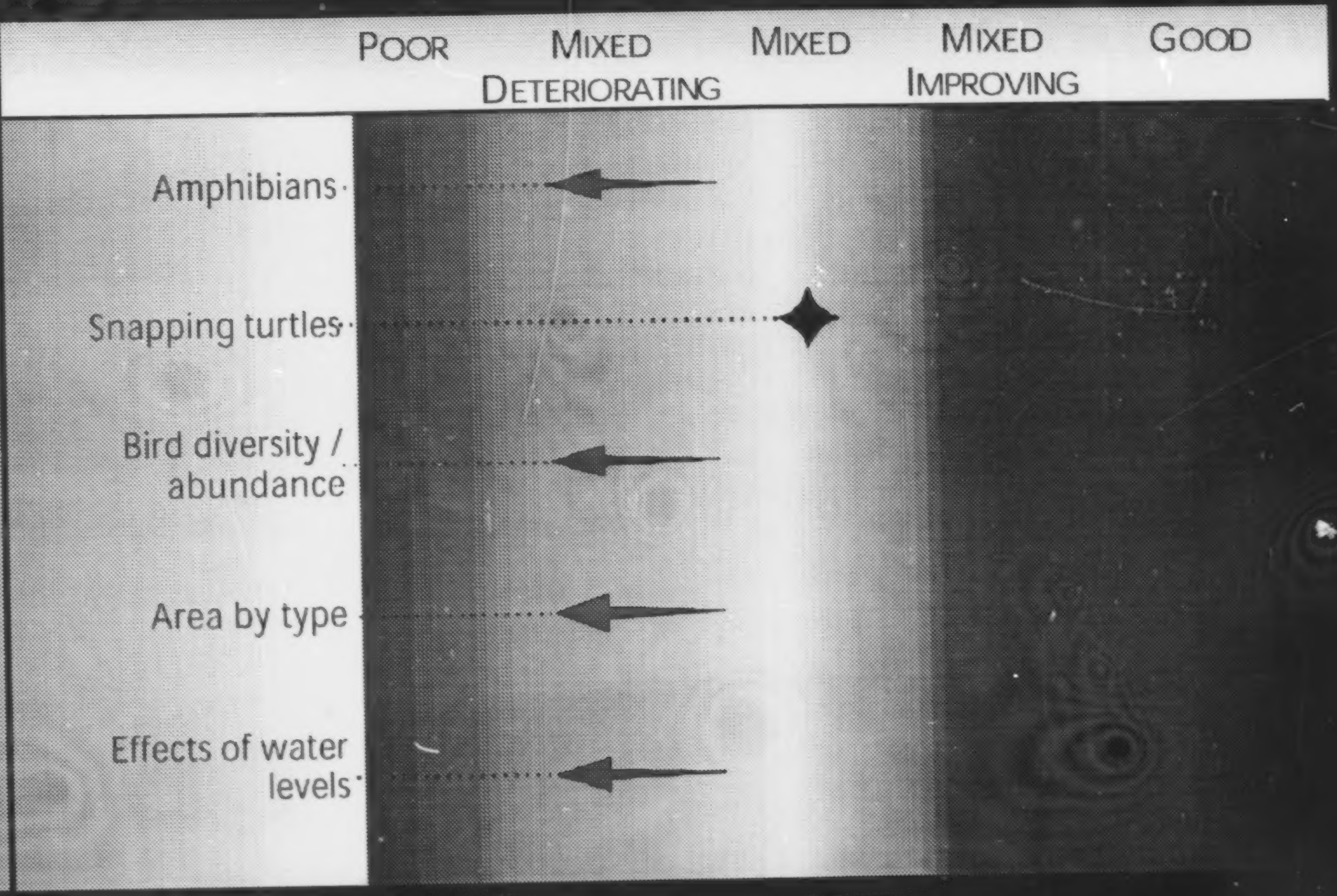
Pennsylvania Department of
Environmental Protection

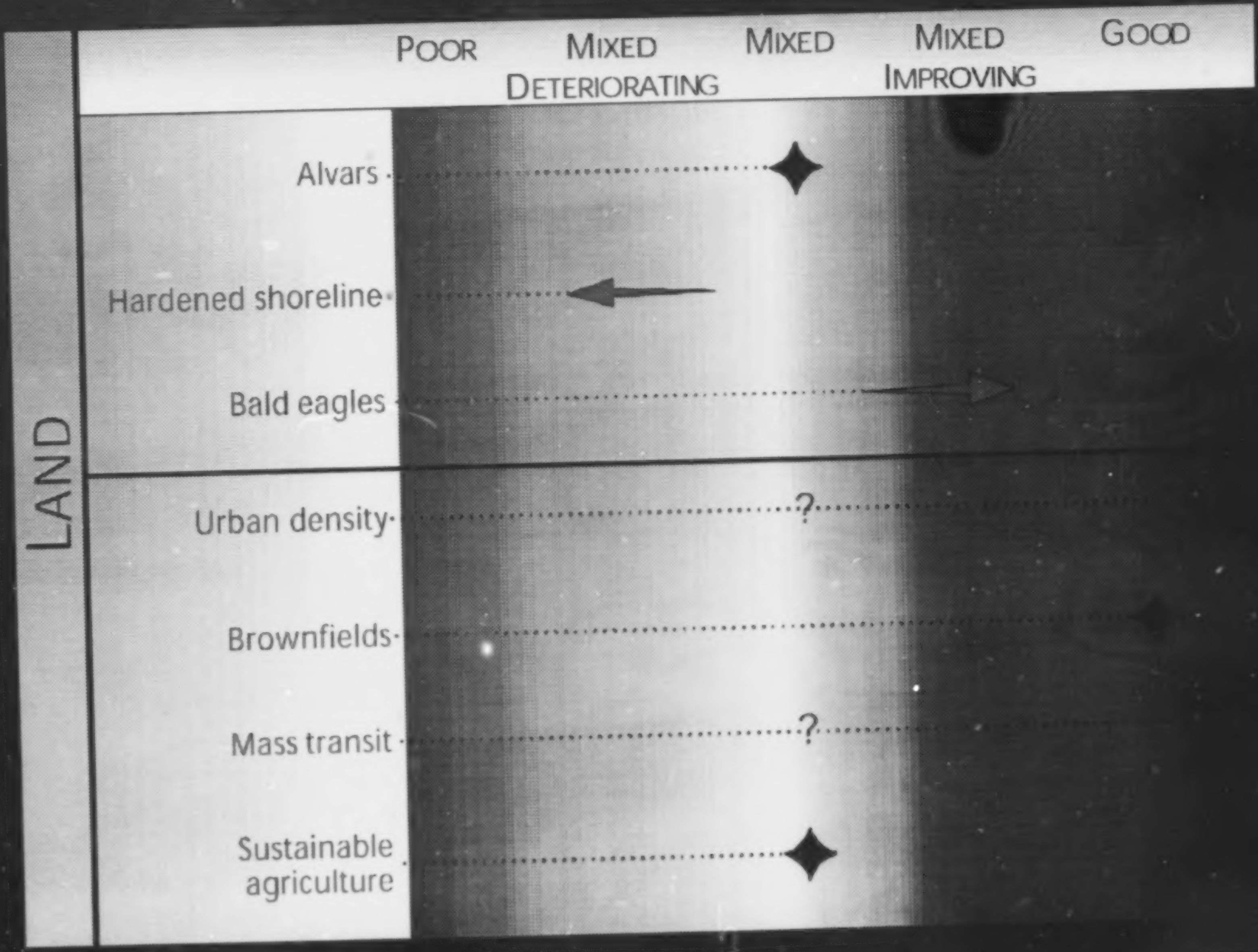

HUMAN HEALTH
POOR
MIXED DETERIORATING
MIXED
MIXED IMPROVING
GOOD
Air Quality
Swimming advisories
Drinking water
Fish consumption advisories

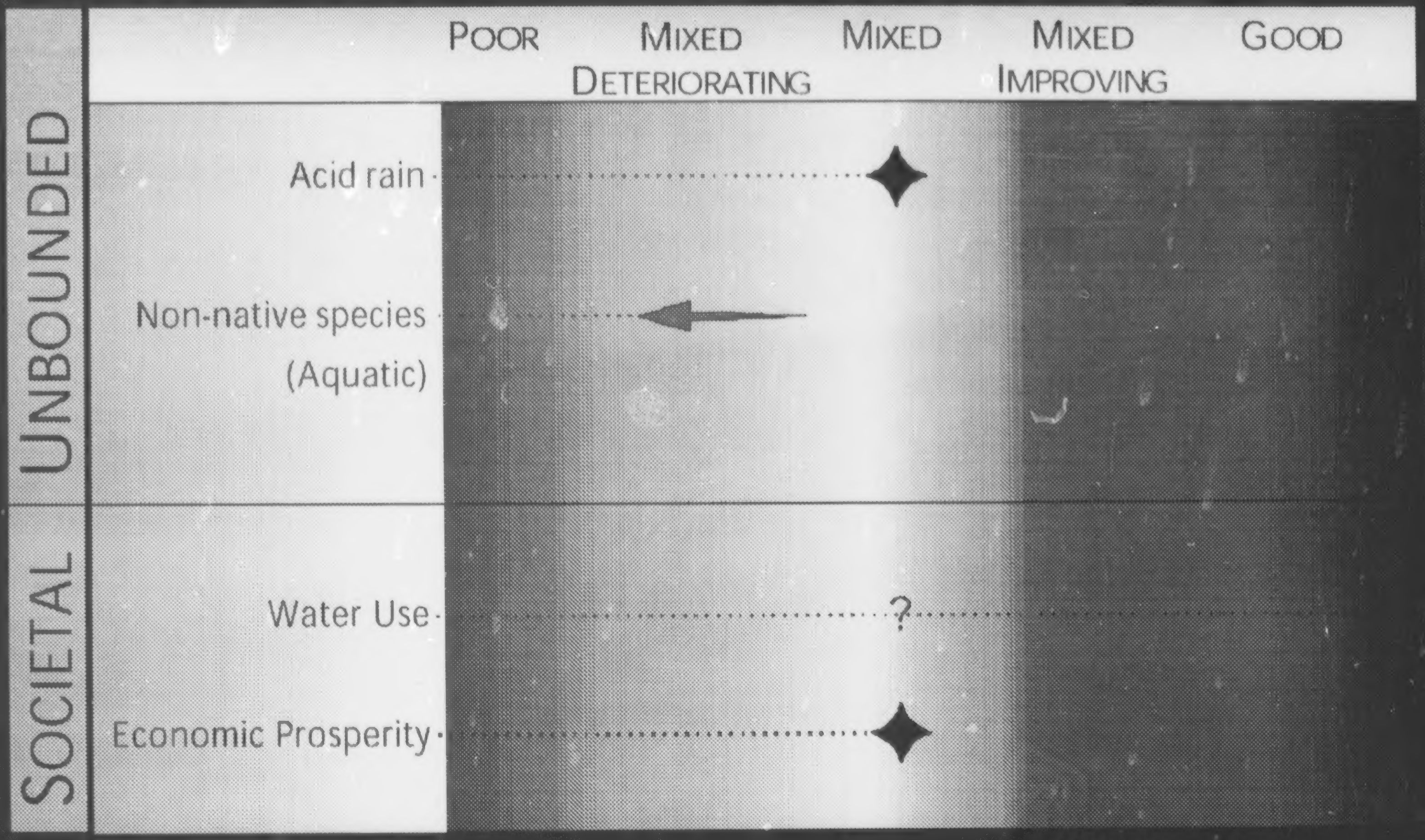
AND NEARSHORE WATERS



COASTAL WETLANDS

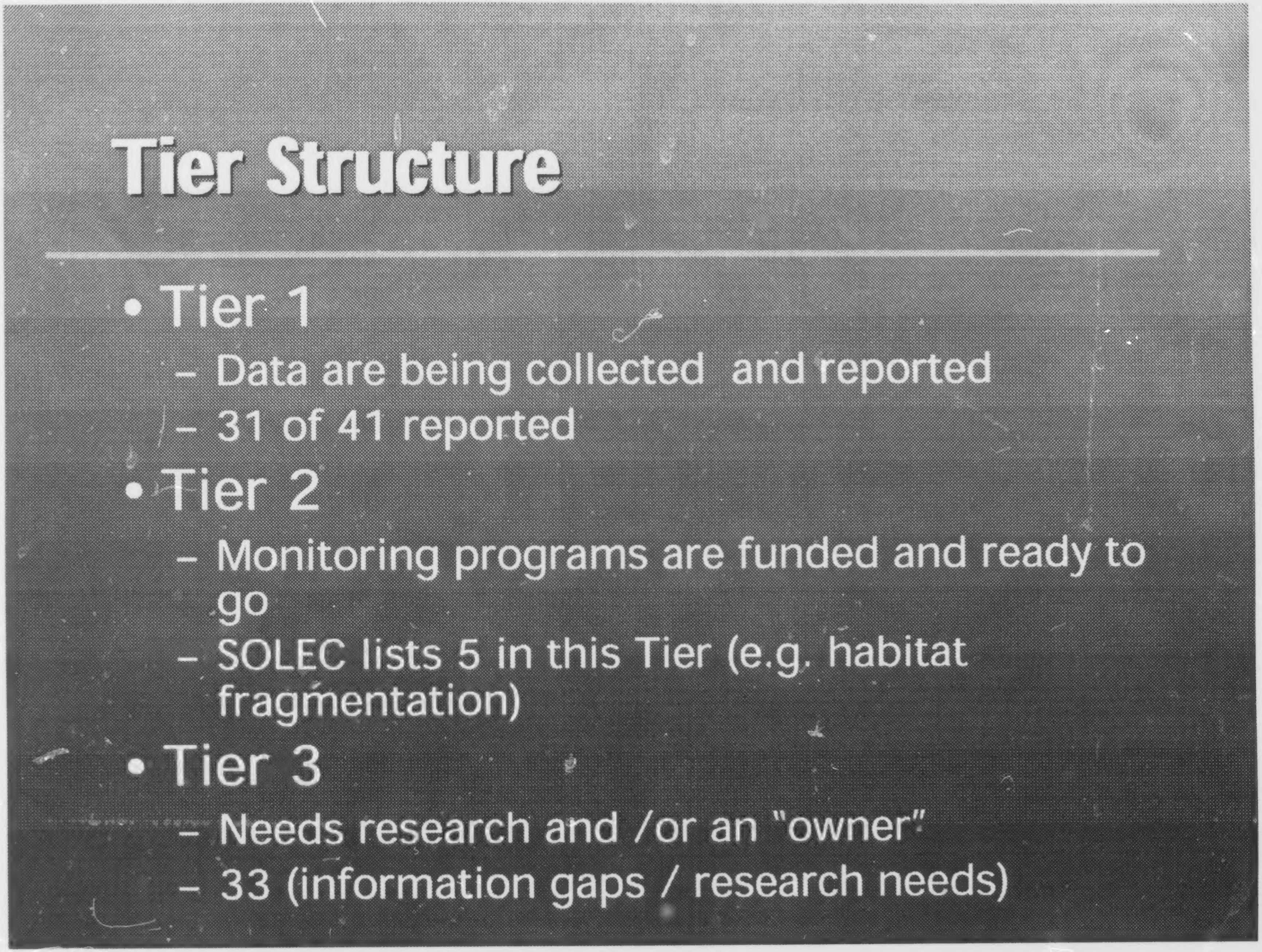



LAND
POOR
MIXED DETERIORATING
MIXED
MIXED IMPROVING
GOOD
Alvars
Hardened shoreline
Bald eagles
Urban density
?
Brownfields
Mass transit
?
Sustainable agriculture


POOR
MIXED DETERIORATING
MIXED
MIXED IMPROVING
GOOD
UNBOUNDED
Acid rain
Non-native species (Aquatic)
SOCIETAL
Water Use
?
Economic Prosperity

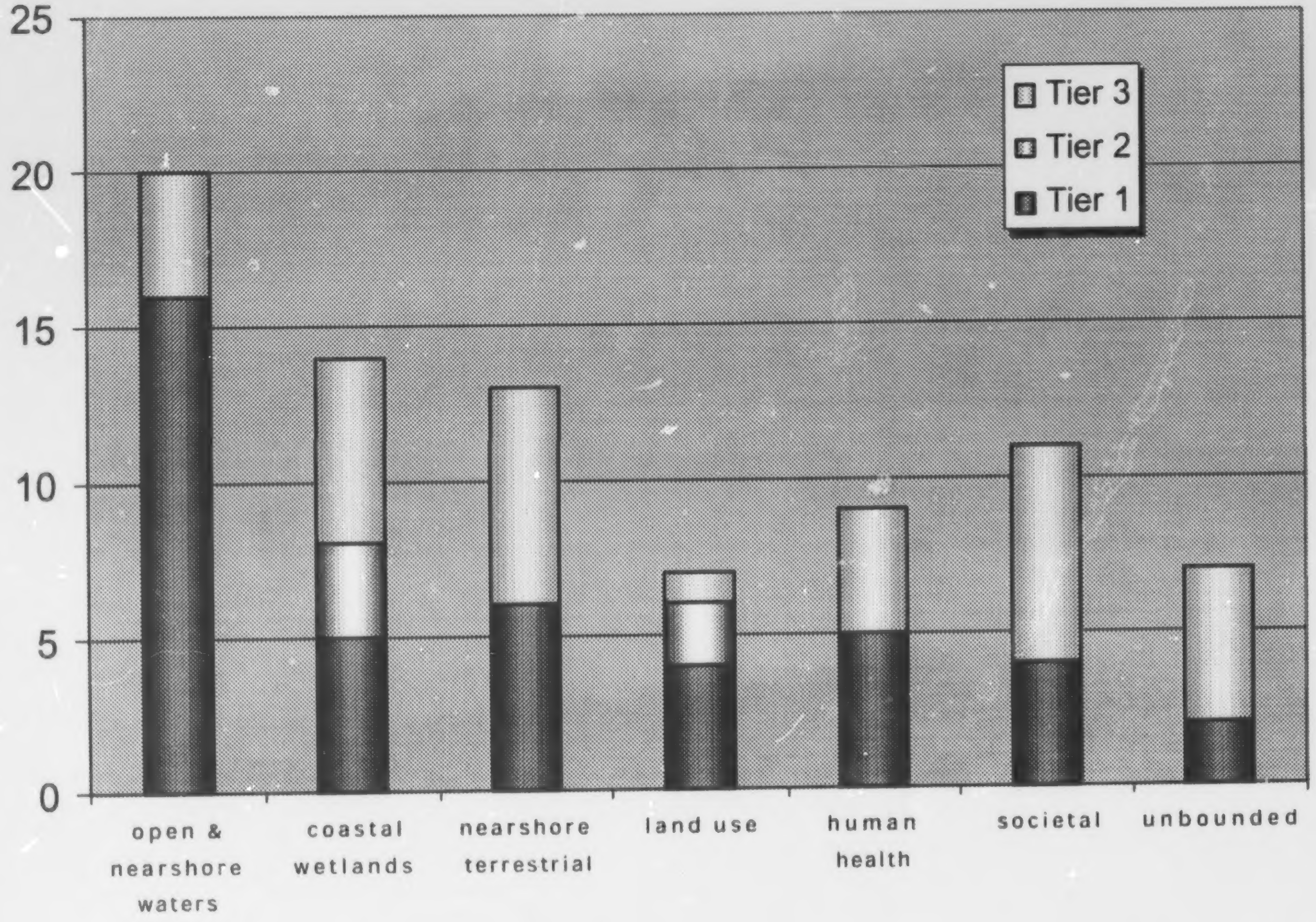
Summary

- Only 31 of the 80 indicators reported for SOLEC 2000
- What about the other indicators?

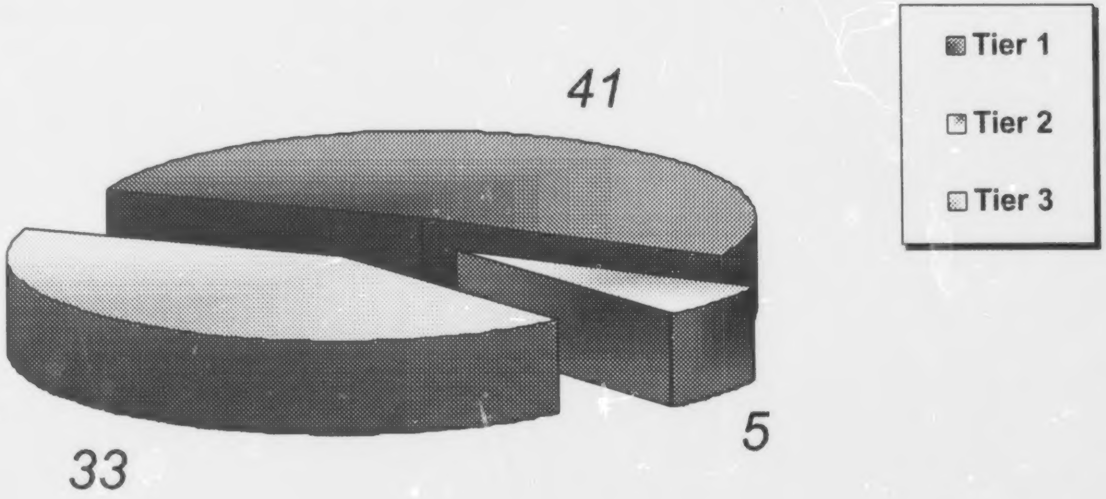


Tier Structure

- Tier 1
  - Data are being collected and reported
  - 31 of 41 reported
- Tier 2
  - Monitoring programs are funded and ready to go
  - SOLEC lists 5 in this Tier (e.g. habitat fragmentation)
- Tier 3
  - Needs research and /or an "owner"
  - 33 (information gaps / research needs)


25
20
15
10
5
0
Tier 3
Tier 2
Tier 1
open & nearshore waters
coastal wetlands
nearshore terrestrial
land use
human health
societal
unbounded

SOLEC Indicators by Tier



Summary - continued

- You have heard draft summary reports
- Assessments in the matrix are "best professional judgement"

SOLEC 2000 indicators reports
are open for peer review
here at SOLEC,
and until January 15, 2001

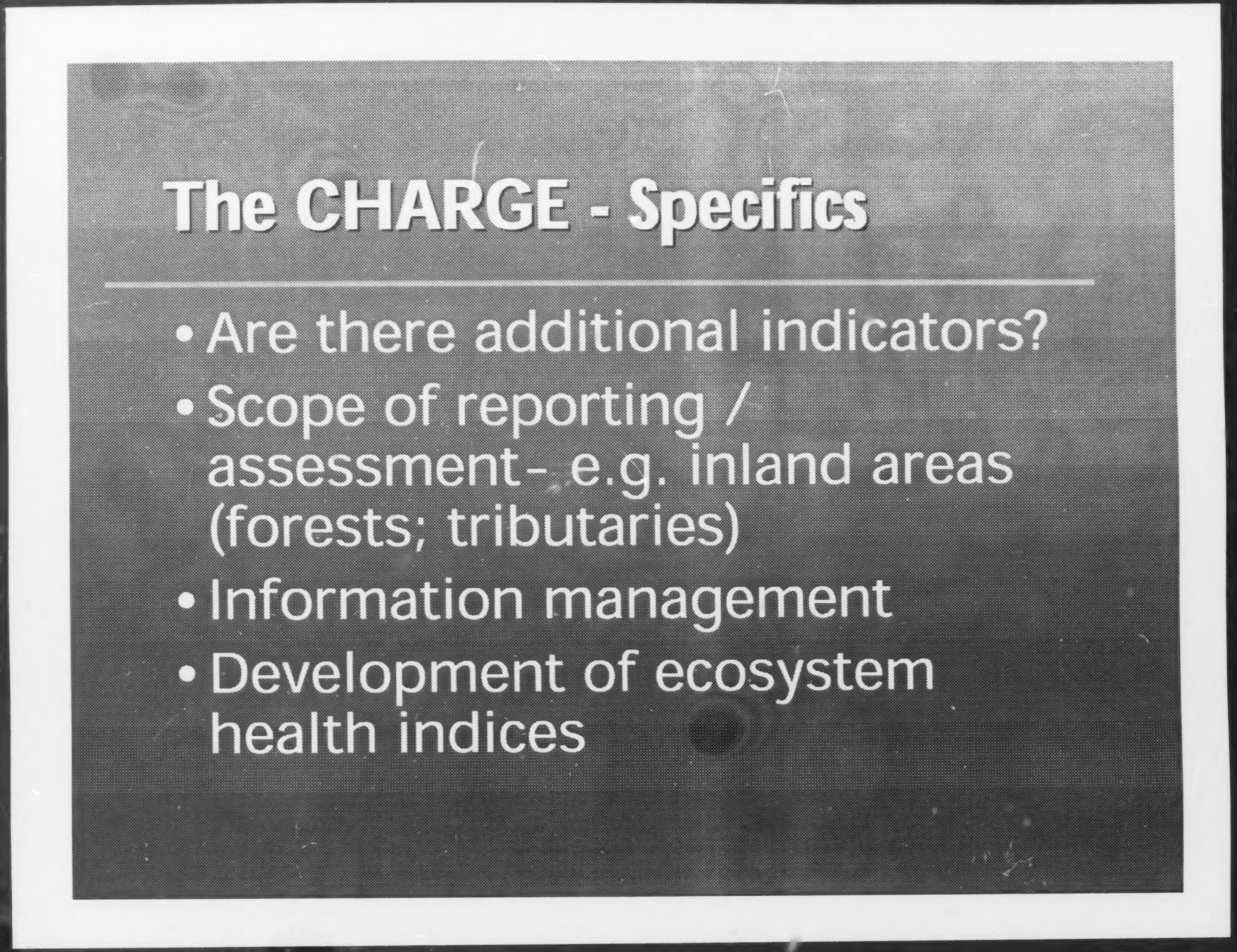
The SOLEC list is
NOT
a Static List

The CHARGE

How Do We Implement The Full Suite Of Indicators To Report More Completely On The State Of The Great Lakes?

The CHARGE - Specifics

- Do you agree with the assessments presented today?
- Do you have additional information?



The CHARGE - Specifics

- Are there additional indicators?
- Scope of reporting / assessment- e.g. inland areas (forests; tributaries)
- Information management
- Development of ecosystem health indices

SOLEC 2000 Day 2

Day1 | Day 2 | Day 3

Hamilton Harbor
A "Success" in the Making
Mark Sproule-Jones
Bay Area Restoration Council
17 pages 7.5Mb

The Environmental
Farm Plan
Ontario Farm Environment
Coalition
13 pages 290Kb

Biodiversity Investment Areas Integration
Ron Reid
Bobolink Enterprises
31 pages 4.8Mb

Putting Indicators to Use
Nancy Stadler-Salt
Environment Canada
7 pages 444Kb

Putting Indicators to Use
Hamilton Harbour Remedial Action Plan
John D. Hall, M.C.I.P., R.P.P.
36 pages 6.1Mb

Amphibian and Bird Indicators for Great Lakes Wetlands: the Marsh Monitoring Program
Russ Weeber & Mary Vallianatos
Bird Studies Canada
20 pages 3.3Mb

International Alvar Conservation Initiative
Heather Potter - The Nature Conservancy
Ron Reid - Couchiching Conservancy
32 pages 5.7Mb

Putting Indicators to Use

Summary & Charge
Nancy Stadler-Salt
Environment Canada
12 pages 1.5Mb

Carbon Sequestration and Biodiversity Management Program
Steve Hounsell
Ontario Power Generation
12 pages 4.4Mb

Water: Ours to Protect
Rural Water Quality Program
15 pages 1.2Mb

Saginaw Bay Watershed Initiative Network
Jim Bredin
Michigan Department of Environmental Quality
15 pages 3.5Mb

Tip of the Mitt Watershed Council
Jill Ryan
11 pages 3.1Mb

XEROX: Engineering Leadership
Anne Stocum
Xerox Corporation
12 pages 91Kb

The Great Lakes Basin Ecosystem Implementing Indicators
Ben Tuggle
US Fish and Wildlife Service
45 pages 3.4Mb

Day1 | Day 2 | Day 3

Hamilton Harbour…
…A “*Success*” in the Making

Presented by:

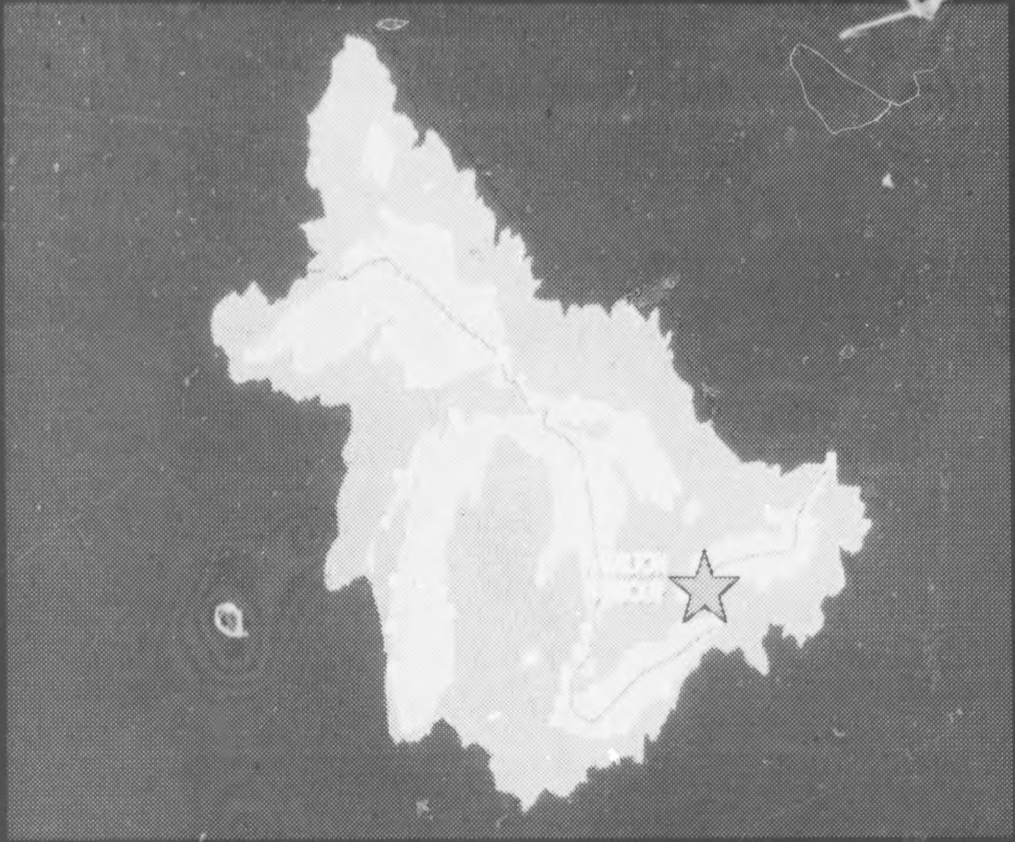
Mark Sproule-Jones, President,
Bay Area Restoration Council (BARC)

Prepared by:

- Mark Sproule-Jones, BARC
- Marilyn Baxter, BARC
- Kathy Trotter, RAP

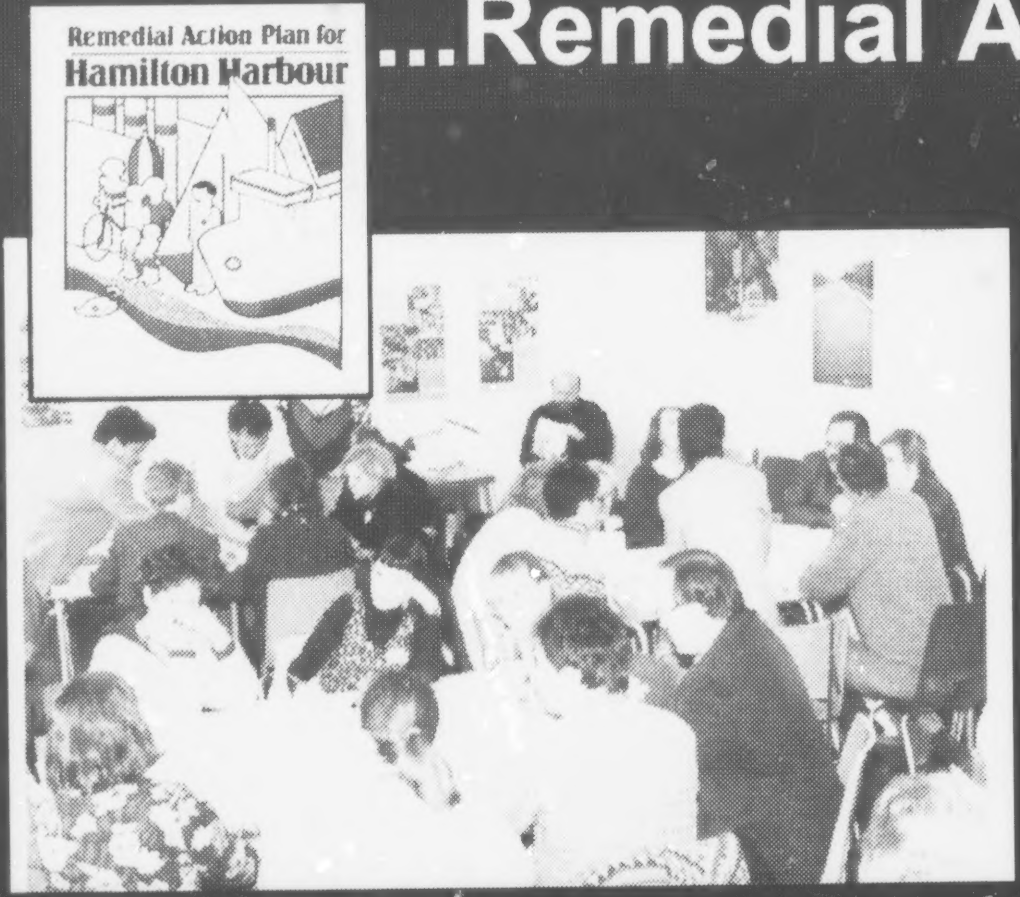
OCTOBER, 2000

Hamilton Harbour...
...Area of Concern



- Natural harbour at the western tip of Lake Ontario

Hamilton Harbour...
...Remedial Action Plan



Remedial Action Plan for
Hamilton Harbour

- Stakeholder approach used as a worldwide model

Hamilton Harbour AOC...
...Current Governance

International Joint Commission

Canada - Ontario Agreement

Hamilton Harbour RAP

BARC

BAIT

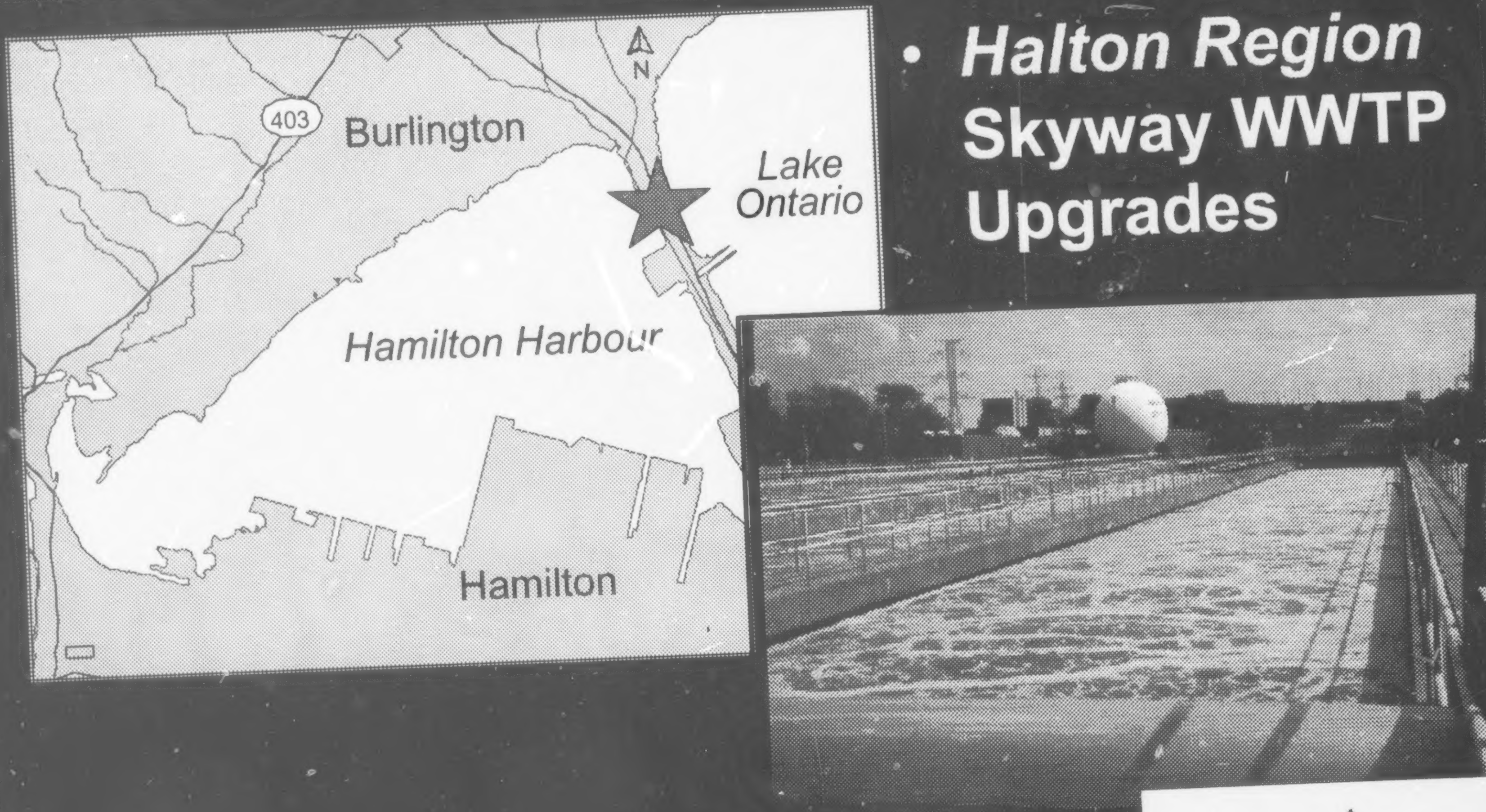
Committees

RAP Forum

Hamilton Harbour...
...Notable Successes

- Improvement in Water Quality
- Creation of Fish & Wildlife Habitat
- Increased Public Access
- Protection of the Watershed

- *Halton Region* Skyway WWTP Upgrades


403
Burlington
N
Lake Ontario
Hamilton Harbour
Hamilton

...Water Quality Improvement...

- *Hamilton-Wentworth Region* Combined Sewer Overflow Tanks

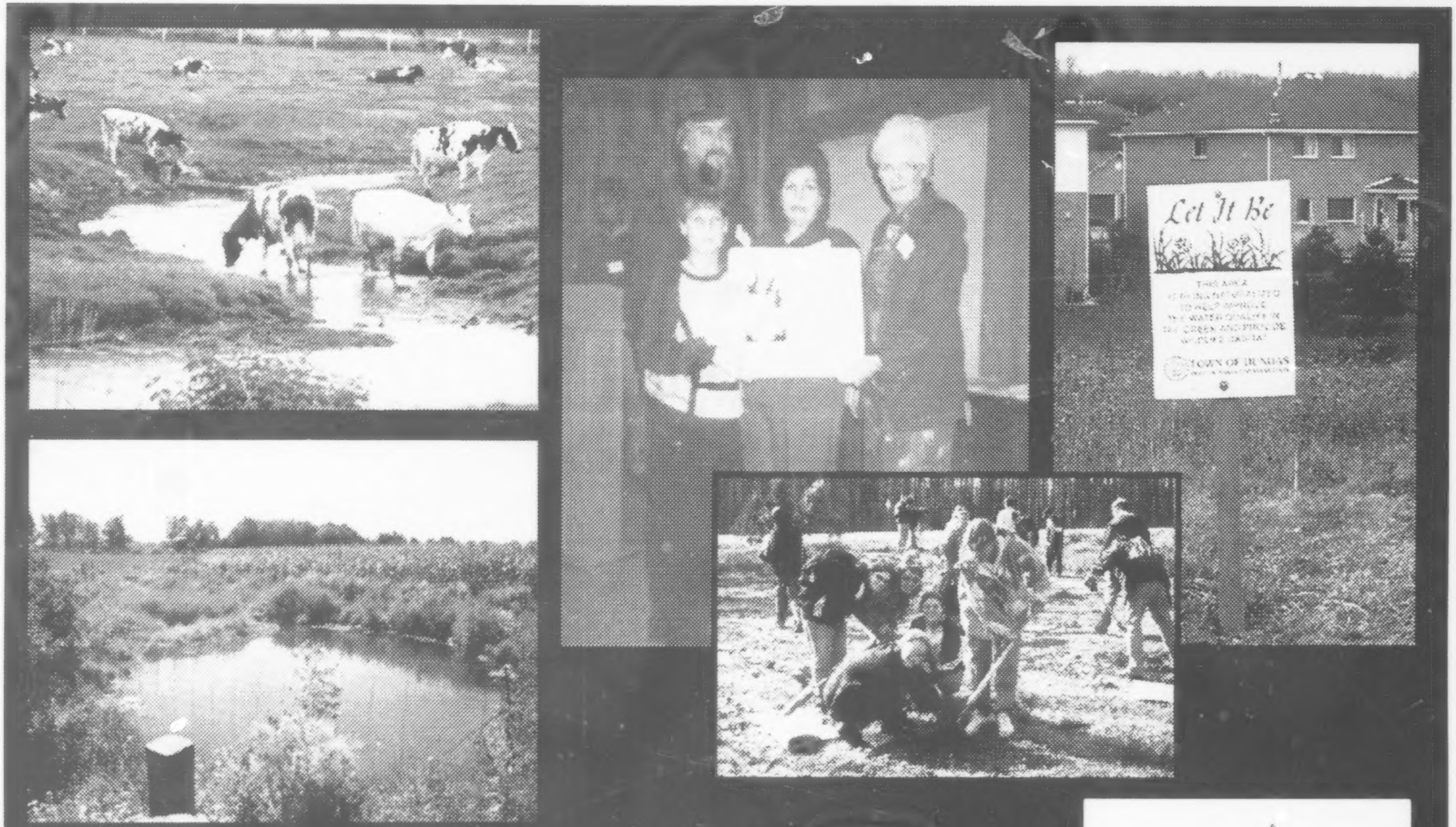
...Water Quality Improvement...

- Industrial Abatement

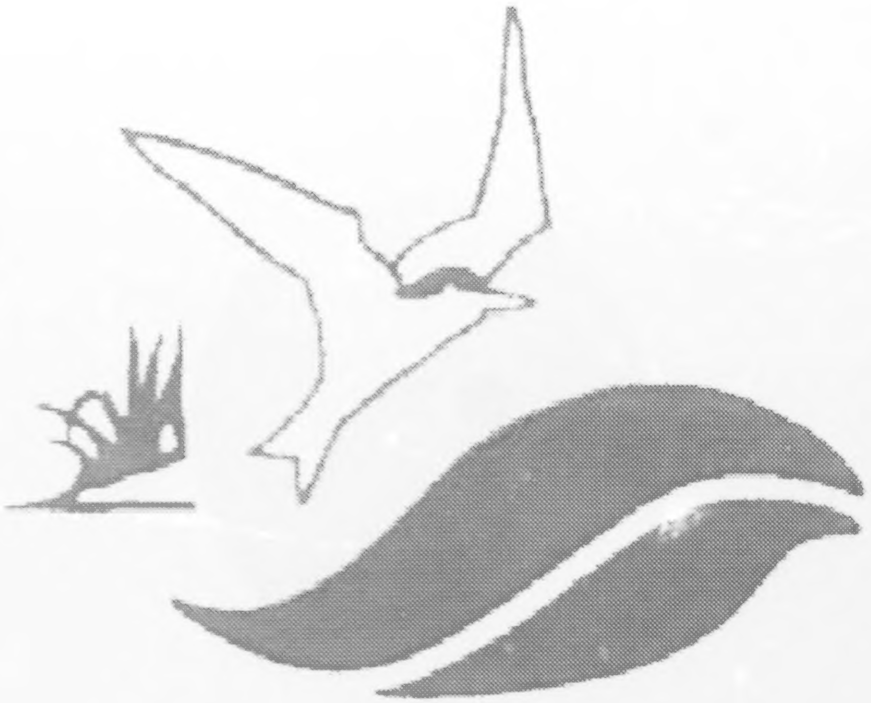
...Water Quality Improvement...

...Fish & Wildlife Habitat Created..

...Increased Public Access...


Let It Be
THIS AREA
TOWN OF DUNDAS

...Protection of the Watershed.



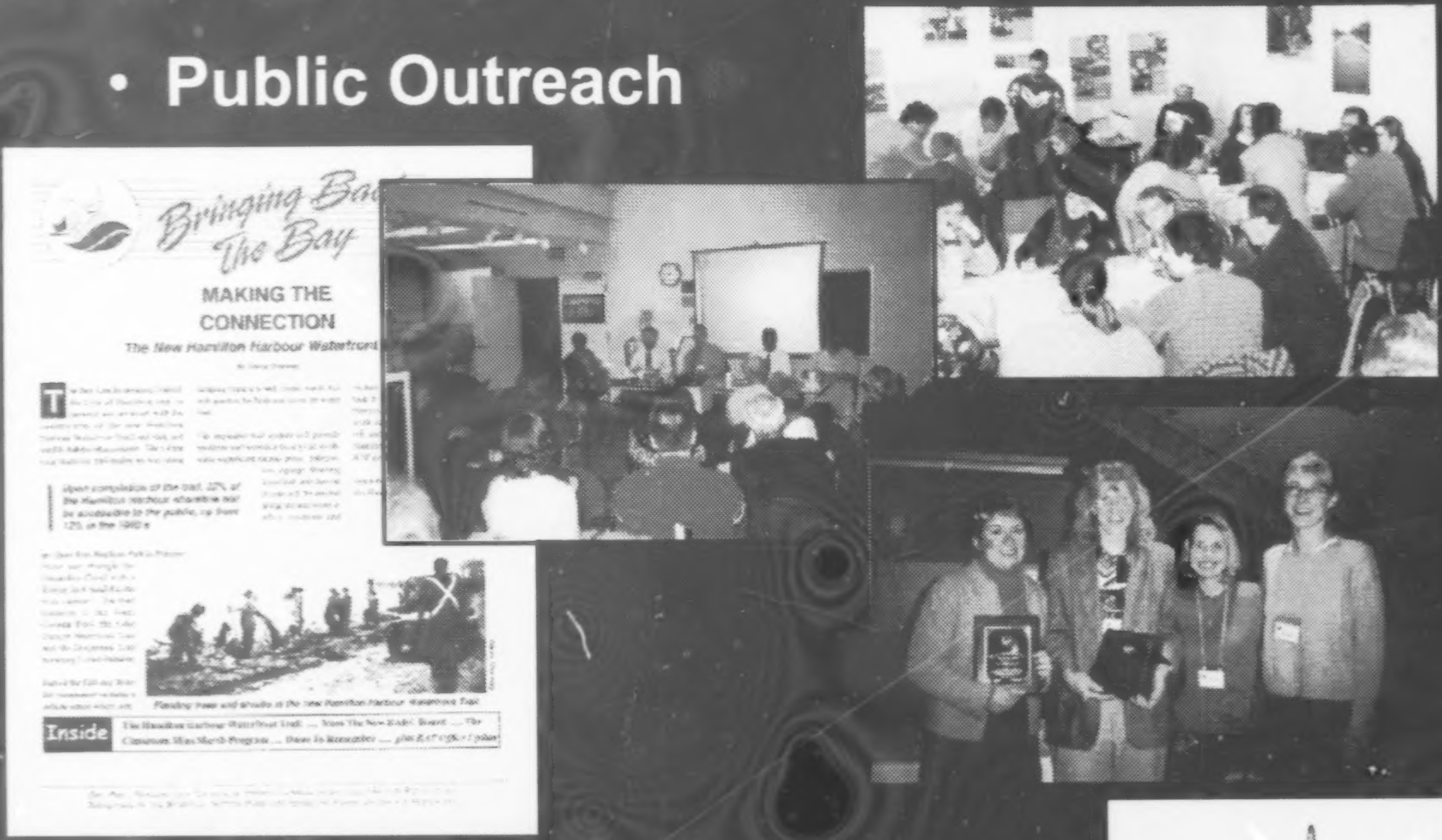
The Bay
Area
Restoration
Council...

...Bringing Back the Bay...

- Community Involvement

...Bringing Back the Bay...

• Public Outreach



Bringing Ba
The Bay

MAKING THE
CONNECTION

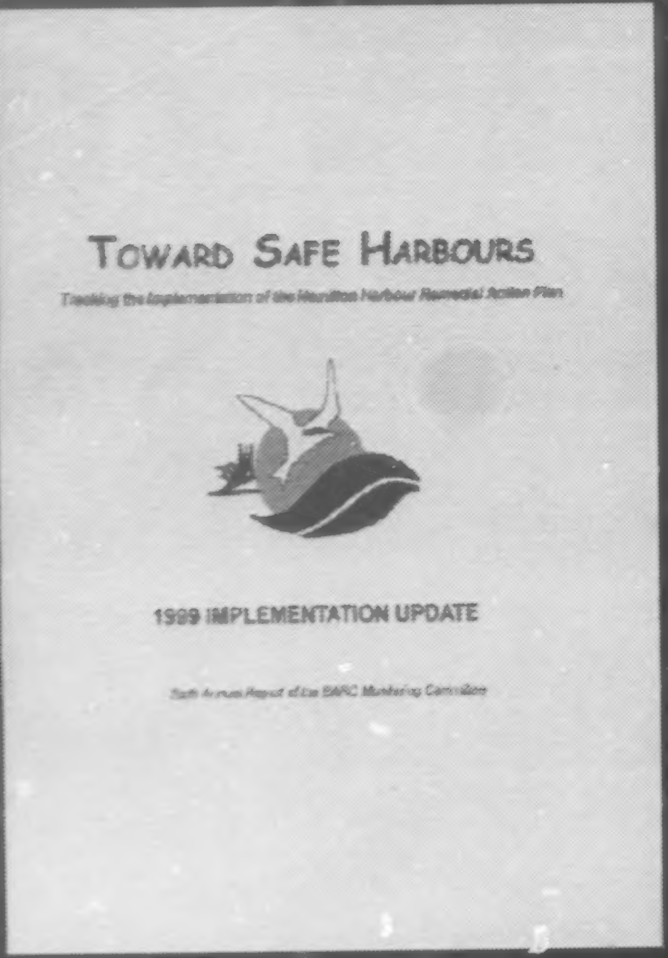
The New Hamilton Harbour Waterfront

Upon completion of the trail, 22% of the Hamilton Harbour shoreline will be accessible to the public, up from 12% in the 1980's

Planting trees and shrubs at the new Hamilton Harbour Waterfront Trail

Inside

...Bringing Back the Bay...



TOWARD SAFE HARBOURS

Tracking the Implementation of the Hamilton Harbour Remedial Action Plan

1999 IMPLEMENTATION UPDATE

Sixth Annual Report of the BARC Monitoring Committee

Annual "*Toward Safe Harbours*" Report

- Industry
- Government
- Local Municipalities
- School Boards
- Community Groups

...Assessing Implementation...

BARC...

...in 2000

Waterfront Trail is worth bragging about

PAST...

PARTNERSHIPS IN ACTION
FISH & WILDLIFE HABITAT RESTO
FRIENDS of the ENVIRONMENT
CITY OF BURLINGTON

...PRESENT...

...AND FUTURE

WE ARE
Bringing Back
The Bay!

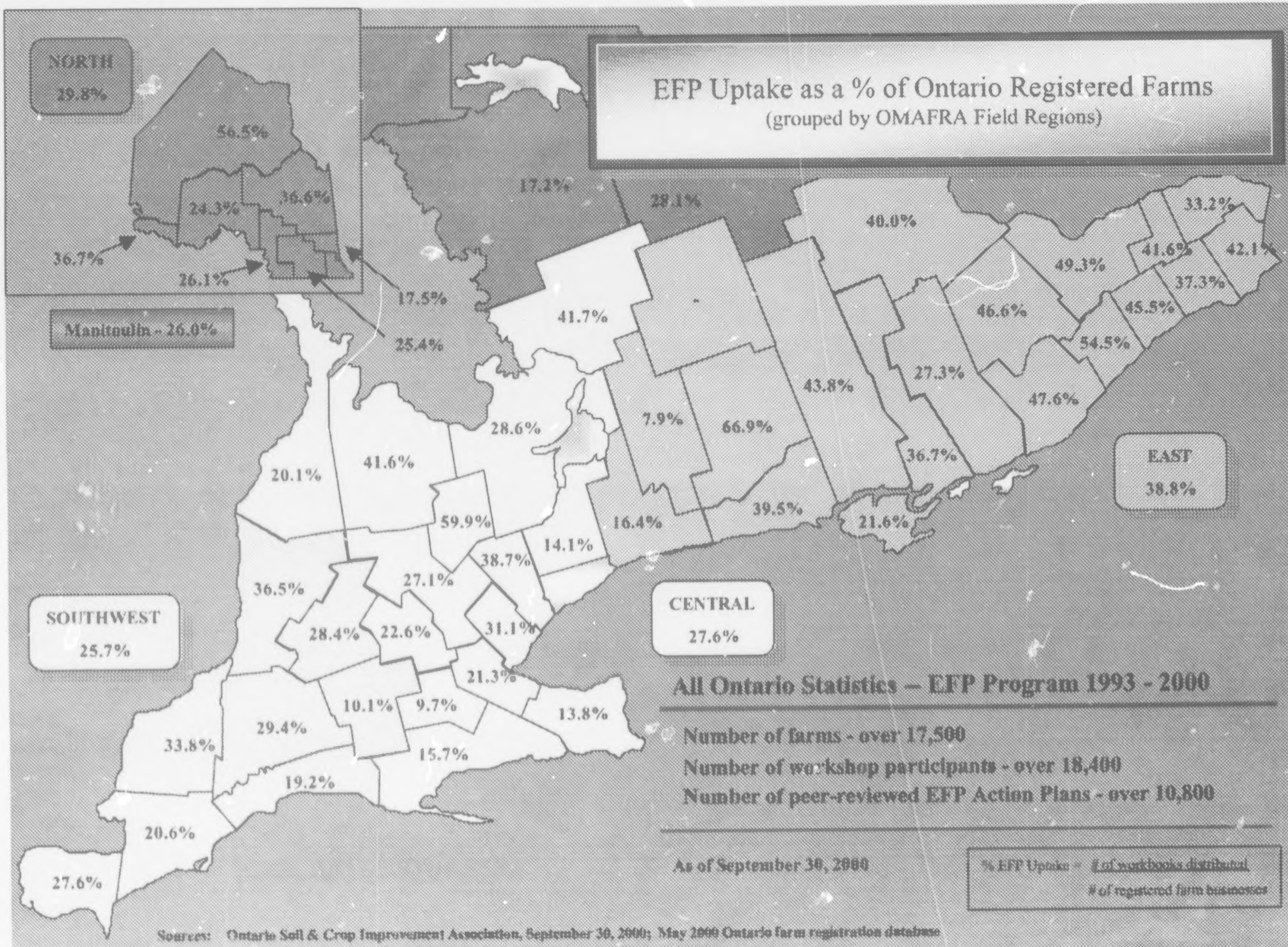
Thank you partners!

THE ENVIRONMENTAL FARM PLAN

ONTARIO FARM ENVIRONMENT COALITION

EFP Uptake as a % of Ontario Registered Farms

(grouped by OMAFRA Field Regions)


NORTH
29.8%
56.5%
24.3%
36.6%
36.7%
26.1%
17.5%
25.4%
Manitoulin - 26.0%
17.2%
28.1%
40.0%
33.2%
42.1%
41.6%
49.3%
37.3%
45.5%
46.6%
54.5%
41.7%
27.3%
43.8%
47.6%
7.9%
66.9%
28.6%
36.7%
41.6%
20.1%
EAST
38.8%
59.9%
16.4%
39.5%
21.6%
14.1%
38.7%
36.5%
27.1%
CENTRAL
27.6%
SOUTHWEST
25.7%
28.4%
22.6%
31.1%
21.3%
10.1%
9.7%
13.8%
33.8%
29.4%
15.7%
19.2%
20.6%
27.6%

All Ontario Statistics – EFP Program 1993 - 2000

Number of farms - over 17,500

Number of workshop participants - over 18,400

Number of peer-reviewed EFP Action Plans - over 10,800

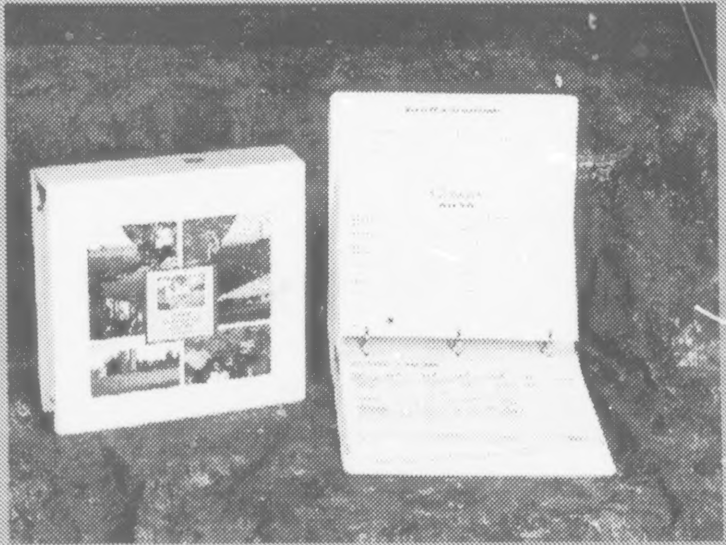
As of September 30, 2000

$$\%\ \text{EFP Uptake} = \frac{\#\text{ of workbooks distributed}}{\#\text{ of registered farm businesses}}$$

Sources: Ontario Soil & Crop Improvement Association, September 30, 2000; May 2000 Ontario farm registration database

OUR FARM ENVIRONMENT AGENDA

- In 1992, 30 of Ontario's Farm Organizations (OFEC) identified 17 key environmental issues facing Agriculture in Ontario
- The vehicle for responding to these issues was through voluntary stewardship using a farm plan
- The target was to have every farm family in Ontario complete a plan by the year 2000



THE FARM PLAN PROCESS

- **WORKSHOP 1** - TRAINING IN SITE EVALUATION AND ASSESSMENT (awareness, education and capacity building)
- **COMPLETE FARM REVIEW** - IMPLEMENT ASSESSMENT (independent action, building commitment and ownership)
- **WORKSHOP 2** - (Developing practical solutions)
- **COMPLETE ACTION PLAN** - (developing initiative and innovation)
- **PEER REVIEW** - PEER INPUT AND REVISIONS (confirming validity and community support)
- **IMPLEMENTATION** - ACTION, MONITORING EVALUATION AND REVISION (continuous quality improvement)

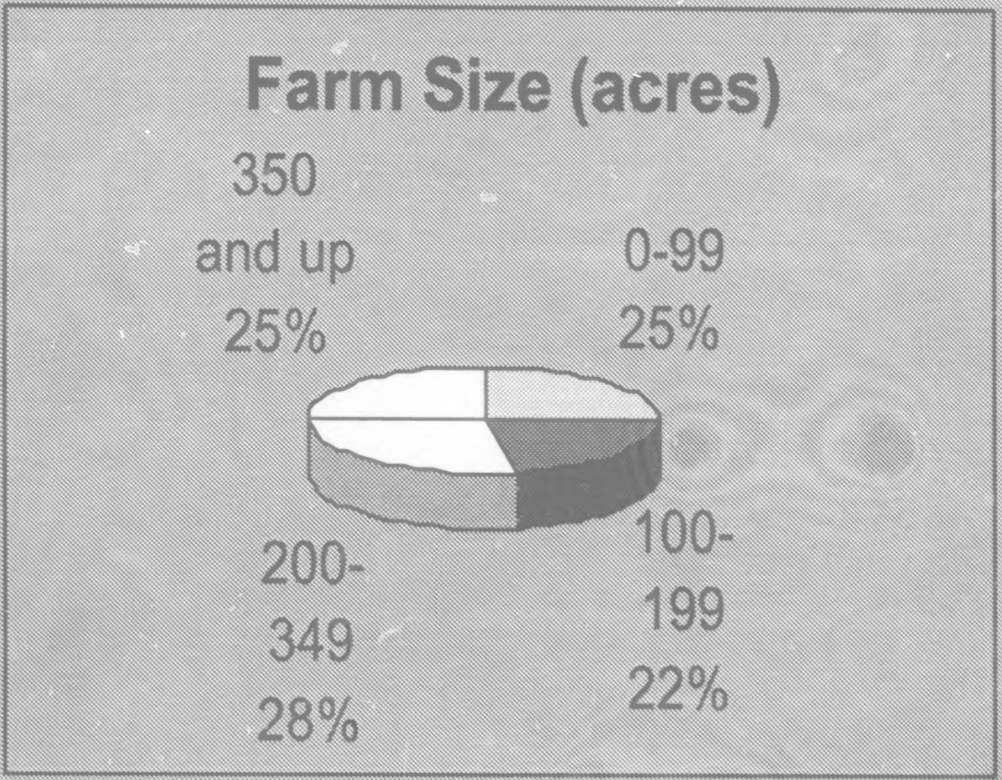
WHAT HAS BEEN ACHIEVED

- 1,217 workshops
- 17,093 participants
- 10,874 plans peer reviewed
- 7889 projects completed
- between 64 and 104 million dollars spent on environmental improvements (peer reviewed plans)
- between 320,000 and 487,00 hours of farm labour

INNOVATIONS

- BUILDING AWARENESS AND CAPACITY FOR ACTION
- PROACTIVE AND PRECAUTIONARY
- FARMING SYSTEM BASED
- VOLUNTARY AND COMMUNITY SUPPORTED
- PROVISION FOR LOCALLY ADAPTED SOLUTIONS

IMPACTS OF FARM ENVIRONMENT PLANNING

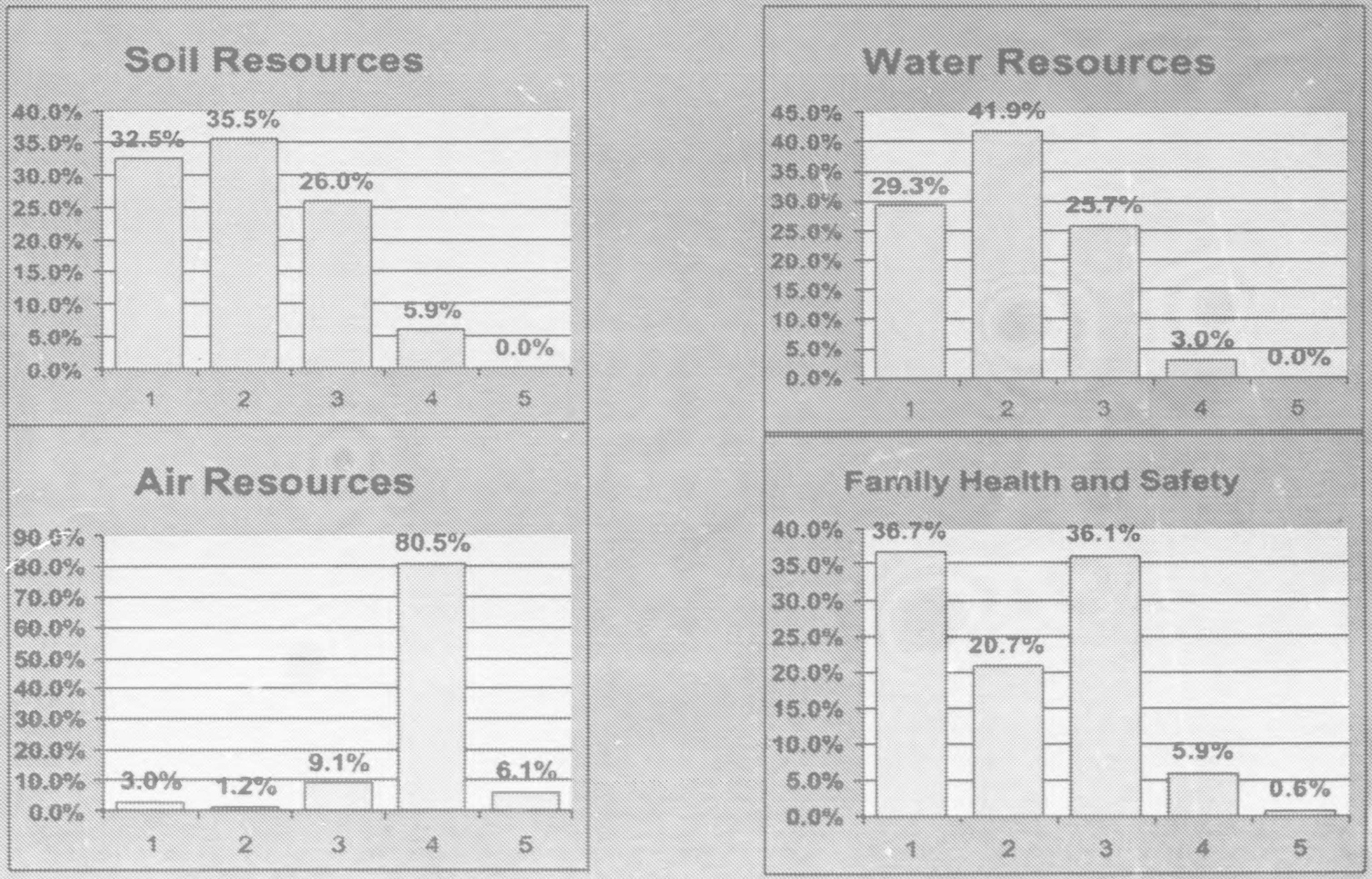


- FARM TYPES COVERED
  - 36 % CASH CROP
  - 15 % DAIRY
  - 14 % MIXED
  - 14 % BEEF
  - 14 % HORTICULTURAL
  - 6 % OTHER ANIMALS
- 2 TO 2.8 MILLION ACRES PEER REVIEWED
- 3.5 TO 4.8 MILLION ACRES ATTENDED WORKSHOPS

IMPACTS OF FARM PLANNING

FARMERS PERCEPTIONS OF ENVIROMENTAL IMPROVEMENTS ACHIEVED THROUGH FARM PLANS

(1 MOST IMPROVED, 5 LEAST IMPROVED)



THIRD PARTY ASSESSMENT OF EFP IMPACTS

IN THE OPINION OF THE PROGRAM REVIEWER THE IMPACTS OF FARM PLAN ON THE FARMS WERE ASSESSED.

(Rated from 1 slight impact to 5 very strong impact.)

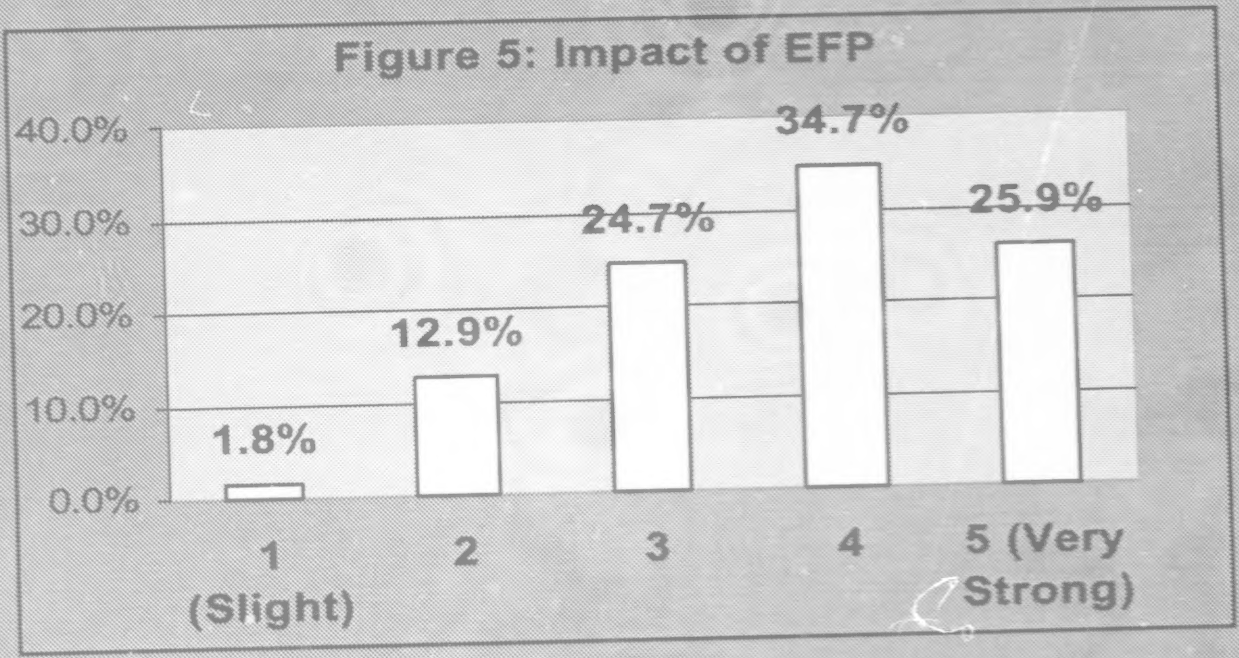
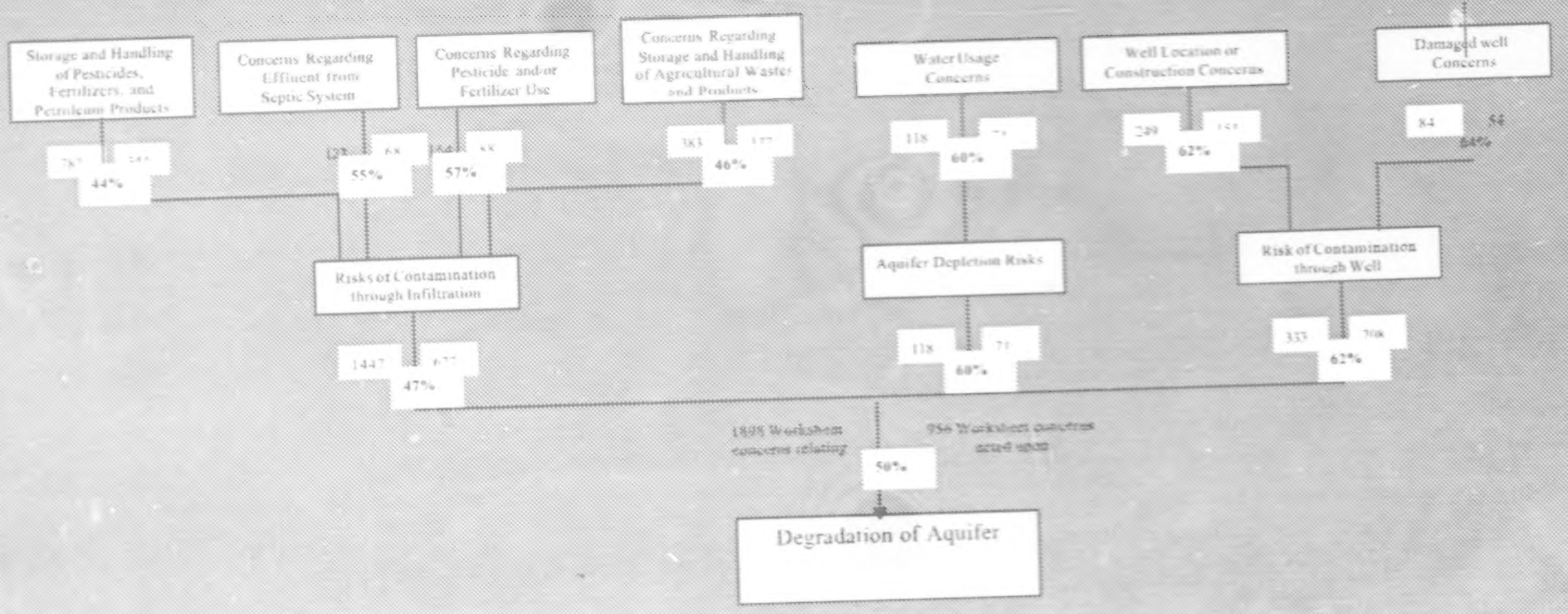


Figure 5: Impact of EFP

ANALYSIS OF PATHWAYS

MITIGATION OF GROUND WATER DEGRADATION

CONTAMINATION PATHWAYS



Storage and Handling of Pesticides, Fertilizers, and Petroleum Products

Concerns Regarding Effluent from Septic System

Concerns Regarding Pesticide and/or Fertilizer Use

Concerns Regarding Storage and Handling of Agricultural Wastes and Products

Water Usage Concerns

Well Location or Construction Concerns

Damaged well Concerns

Risks of Contamination through Infiltration

Aquifer Depletion Risks

Risk of Contamination through Well

1898 Worksheet concerns relating

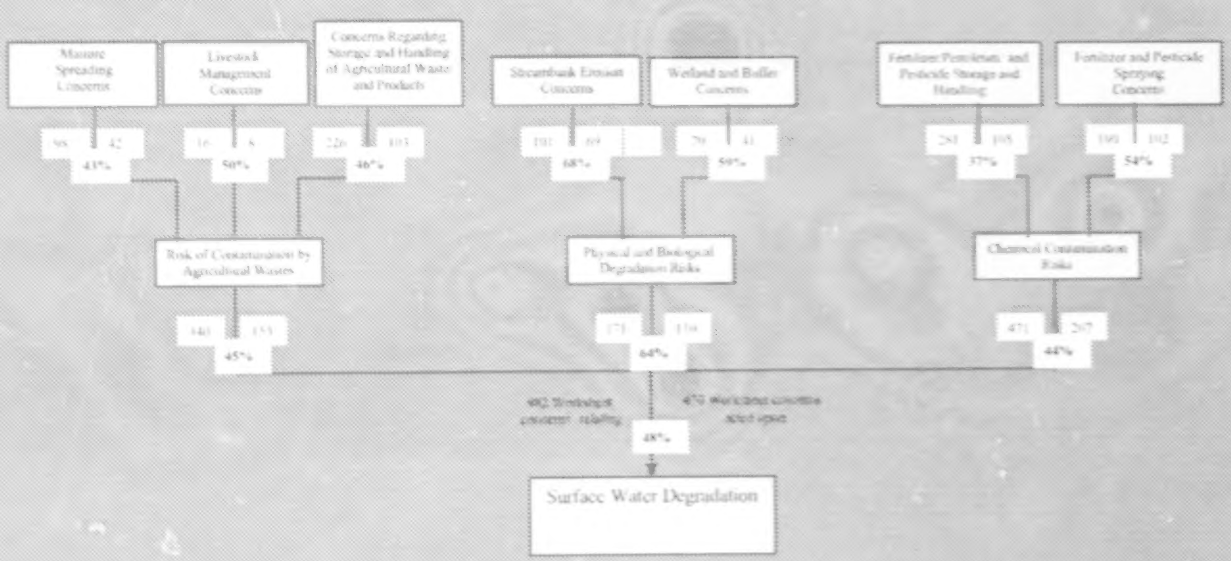
956 Worksheet concerns acted upon

Degradation of Aquifer

ANALYSIS OF PATHWAYS

MITIGATION OF SURFACE WATER DEGRADATION

SURFACE WATER CONTAMINATION PATHWAYS



Manure Spreading Concerns

98 42

43%

Livestock Management Concerns

16 8

50%

Concerns Regarding Storage and Handling of Agricultural Waste and Products

226 103

46%

Risk of Contamination by Agricultural Wastes

340 153

45%

Streambank Erosion Concerns

101 69

68%

Wetland and Buffer Concerns

70 41

59%

Physical and Biological Degradation Risks

171 110

64%

Fertilizer/Petroleum and Pesticide Storage and Handling

281 105

37%

Fertilizer and Pesticide Spraying Concerns

190 102

54%

Chemical Contamination Risks

471 207

44%

982 [illegible] concerns relating

470 [illegible] concerns acted upon

48%

Surface Water Degradation

NEW ISSUES

- PROTECTION OF SPECIES
- REDUCTION OF GREENHOUSE GASSES
- CARBON SEQUESTERING
- REGULATION IN SUPPORT OF STEWARDSHIP

NEXT STEPS

- REVISION OF THE WORKBOOK TO MEET NEW CHALLENGES
- UPDATING OF EXISTING FARM PLANS
- IMPROVEMENT OF BEST PRACTICES
- IMPROVED MONITORING AND EVALUATION

Biodiversity Investment Areas Integration

Ron Reid – *Bobolink Enterprises*
Karen Rodriguez – *US EPA GLNPO*
Heather Potter & Michele DePhilip –
The Nature Conservancy

Biodiversity Investment Areas
Basis for Progress

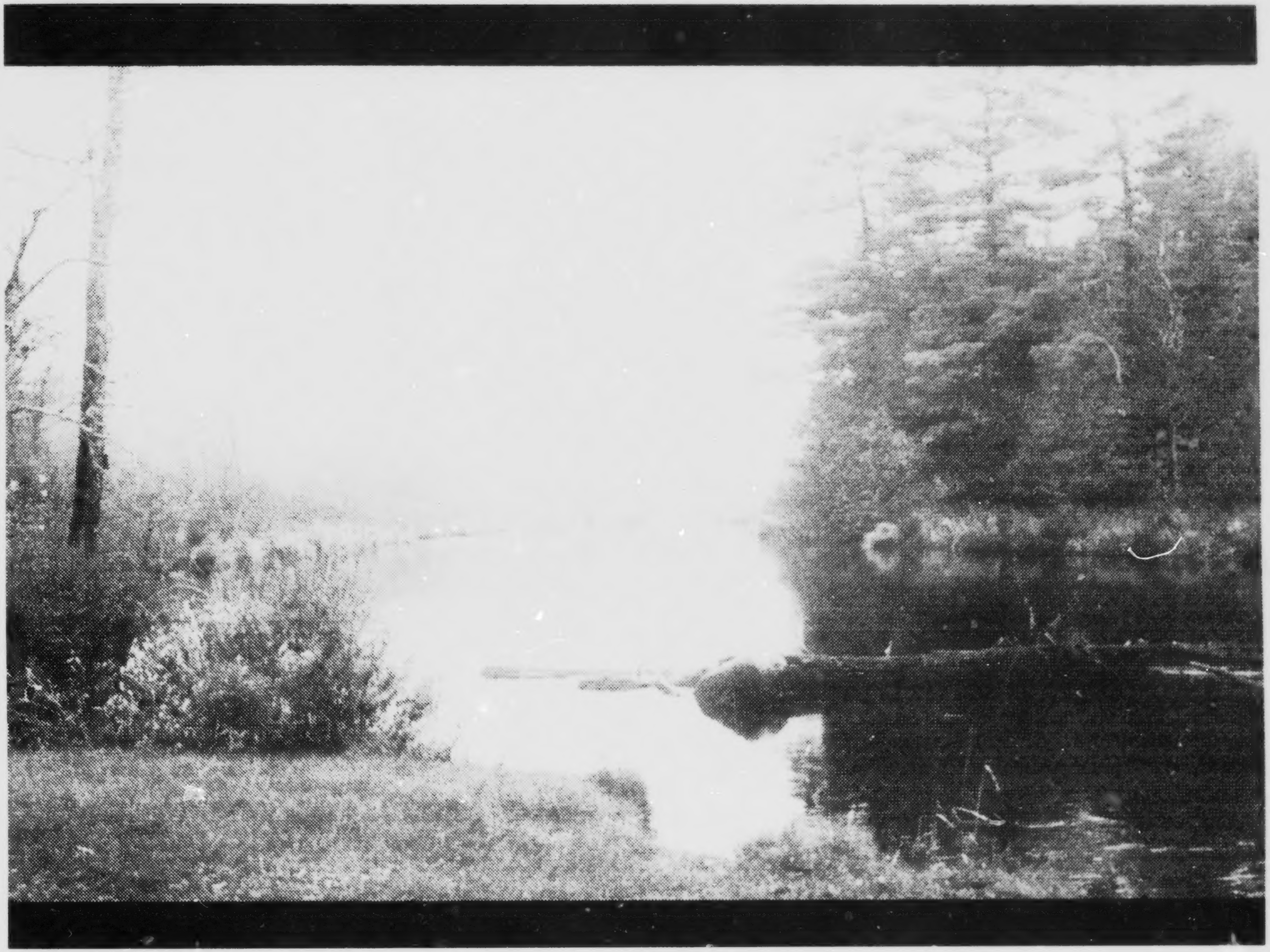
- Original concept at SOLEC 1996
- SOLEC 1998 – background papers on terrestrial, wetlands, aquatic
- Need for a single over-arching BIA system
- IJC recommendation

Biodiversity Investment Areas (BIAs)

- Broad areas
- Clusters of values
- Coastal areas
- High potential for restoration as well as pristine

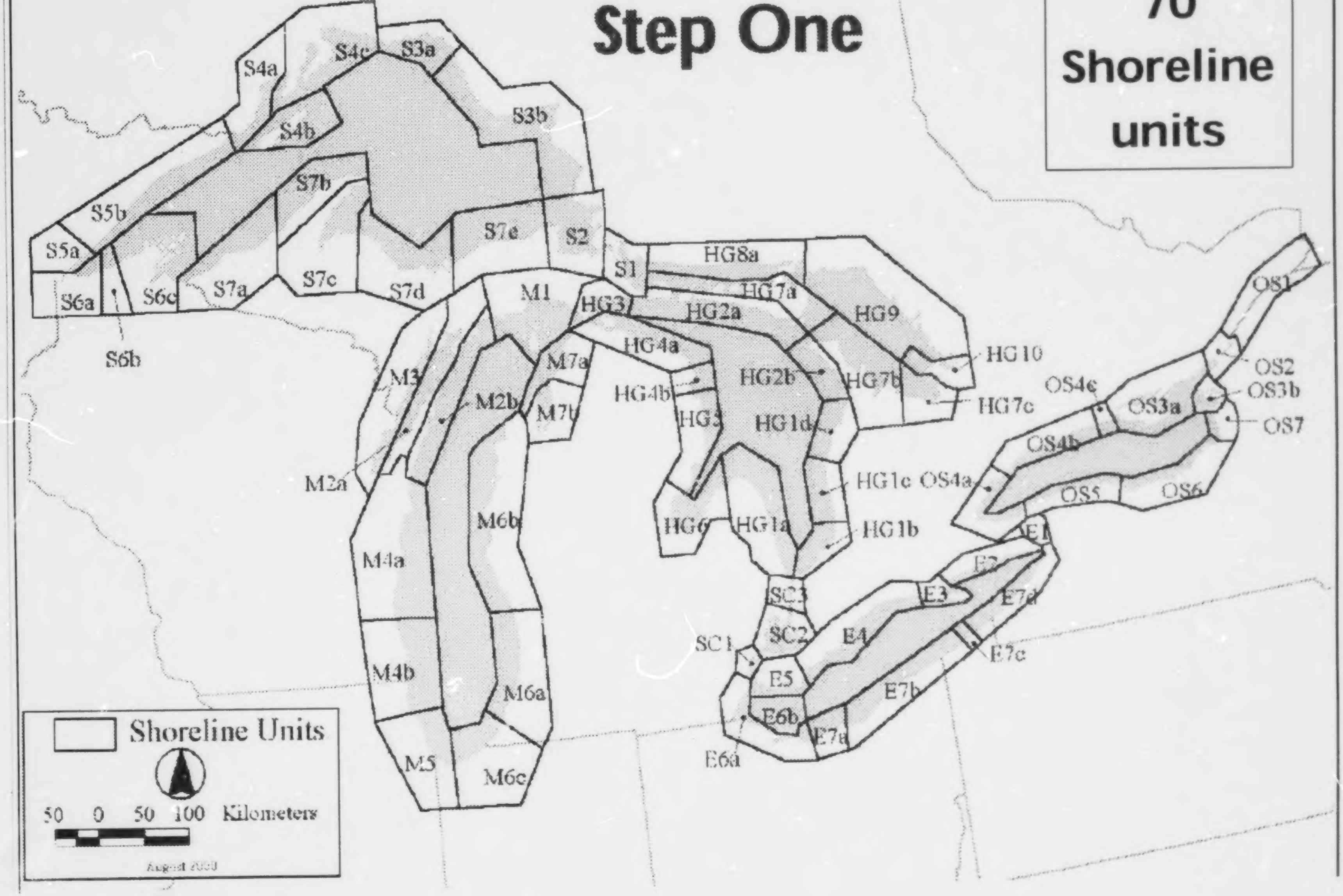
Why BIAs?

- Focus attention
- Engage citizens and agencies
- Great Lakes Water Quality Agreement goal
- International commitments
- Benchmarks for ecological indicators



Integration Process
Step One

70
Shoreline
units


S4a
S4c
S3a
S3b
S4b
S7b
S5b
S5a
S6a
S6b
S6c
S7a
S7c
S7d
S7e
S2
S1
HG8a
HG7a
HG9
HG10
HG7b
HG7c
HG2a
HG3
M1
HG4a
HG4b
HG2b
HG5
HG1d
HG1c
HG1b
HG6
HG1a
M7a
M7b
M3
M2b
M2a
M6b
M4a
M4b
M6a
M5
M6c
SC3
SC2
SC1
E5
E6b
E6a
E7a
E7b
E7c
E4
E3
E2
E7d
E1
OS1
OS2
OS3b
OS7
OS3a
OS4c
OS4b
OS4a
OS5
OS6
Shoreline Units
50 0 50 100 Kilometers
August 2000

Integration Process
Step Two

- Develop integrated over-arching criteria
- *Criterion 1: Species or communities of special interest*
- *Criterion 2: Diversity of habitats, communities and species*
- *Criterion 3: Productivity and integrity*

Integration Process
Step Three

- Identify available data sets to assess each criterion

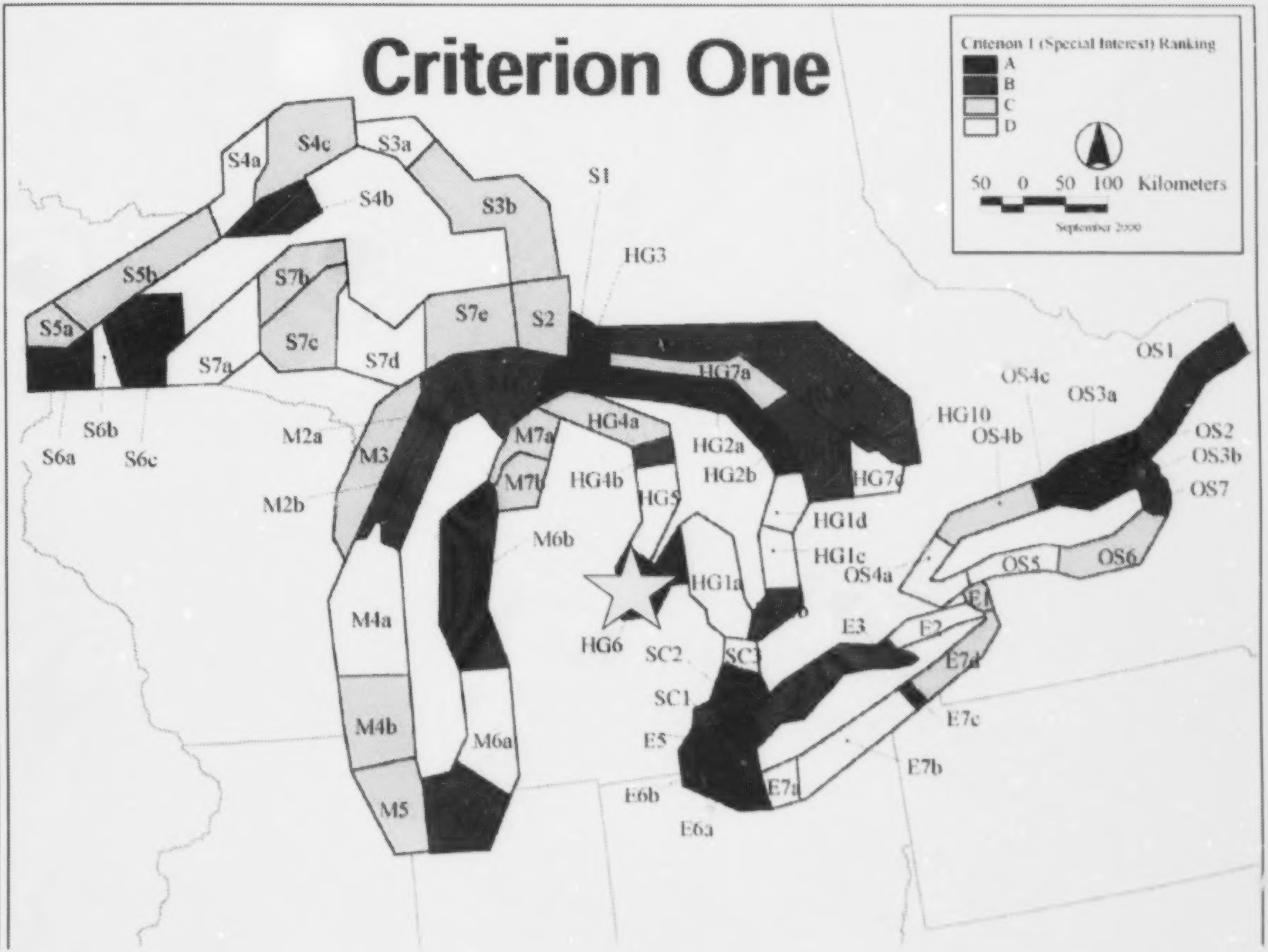
- 10 data sets used

- For each data set, compare relative values for each shoreline unit - adjust for shoreline length

- Compile to derive a relative rank for each criterion

Data sets for Criterion 1
Special communities/species

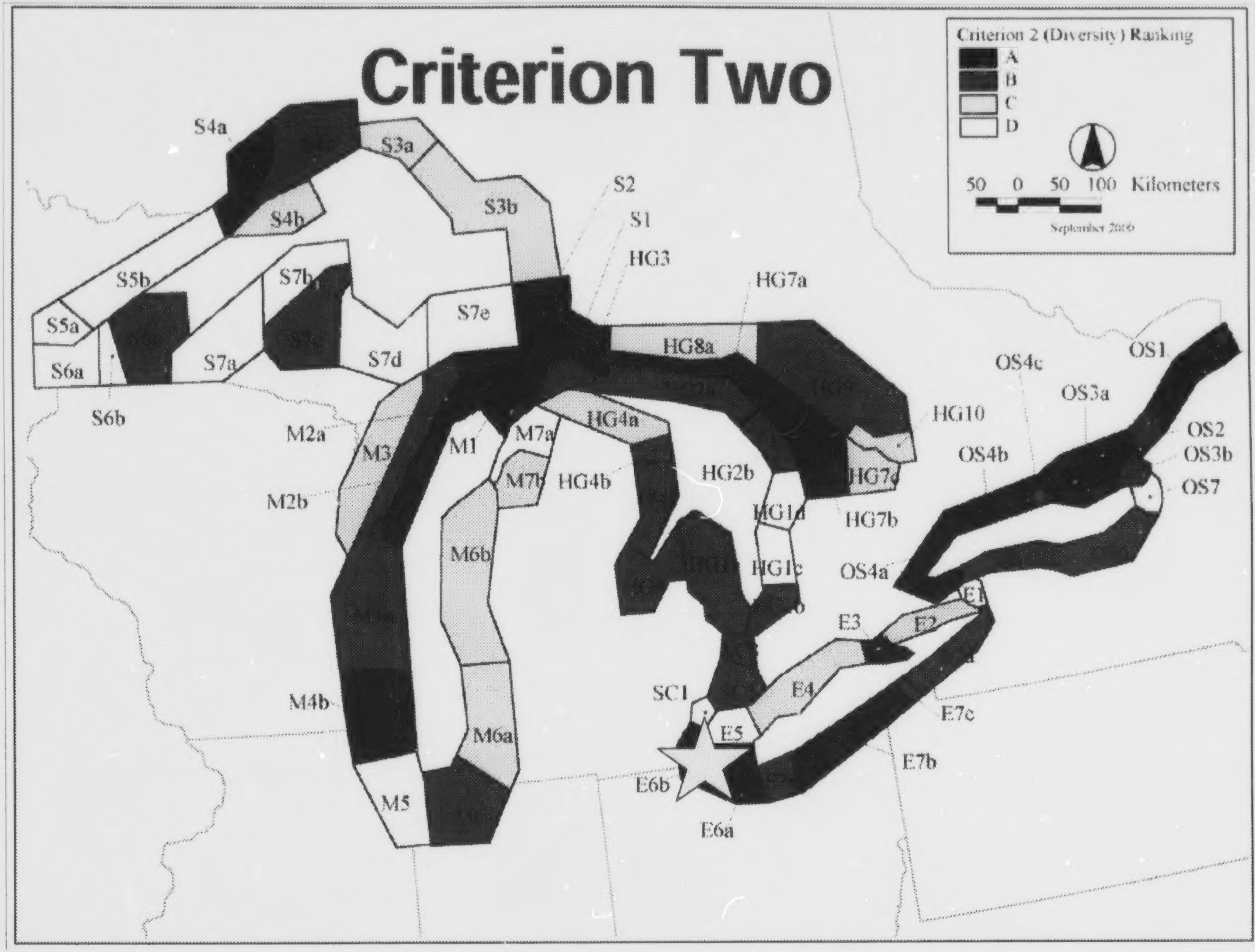
- Rare species and community occurrences
- High-quality habitat areas
- Coastal wetlands
- Important Bird Areas


Criterion One
Criterion 1 (Special Interest) Ranking
A
B
C
D
50 0 50 100 Kilometers
September 2000
S4a
S4c
S3a
S4b
S3b
S1
S5b
S7b
HG3
S5a
S7e
S2
S7c
S7a
S7d
S6b
S6a
S6c
M2a
M3
M2b
HG7a
HG4a
M7a
M7b
HG4b
HG5
HG2a
HG2b
HG7c
HG10
OS4c
OS3a
OS1
OS4b
OS2
OS3b
OS7
HG1d
HG1c
M6b
HG1a
OS4a
OS5
OS6
M4a
HG6
SC2
SC3
SC1
E3
E2
E7d
M4b
M6a
E5
E7c
E7b
E6b
E7a
M5
E6a

Data sets for Criterion 2
Diversity

- Shoreline substrate diversity
- Shoreline complexity
- Fish spawning and nursery areas

Criterion Two


Criterion 2 (Diversity) Ranking
A
B
C
D
50 0 50 100 Kilometers
September 2006
S4a
S3a
S3b
S4b
S5b
S5a
S6a
S6b
S7b
S7a
S7d
S7e
S2
S1
HG3
HG7a
HG8a
HG10
HG7c
HG7b
HG4a
HG4b
HG2b
HG1d
HG1c
M1
M2a
M2b
M3
M7a
M7b
M6b
M6a
M4b
M5
OS1
OS4c
OS3a
OS2
OS3b
OS7
OS4b
OS4a
E1
E2
E3
E4
E5
E6a
E6b
E7b
E7c
SC1

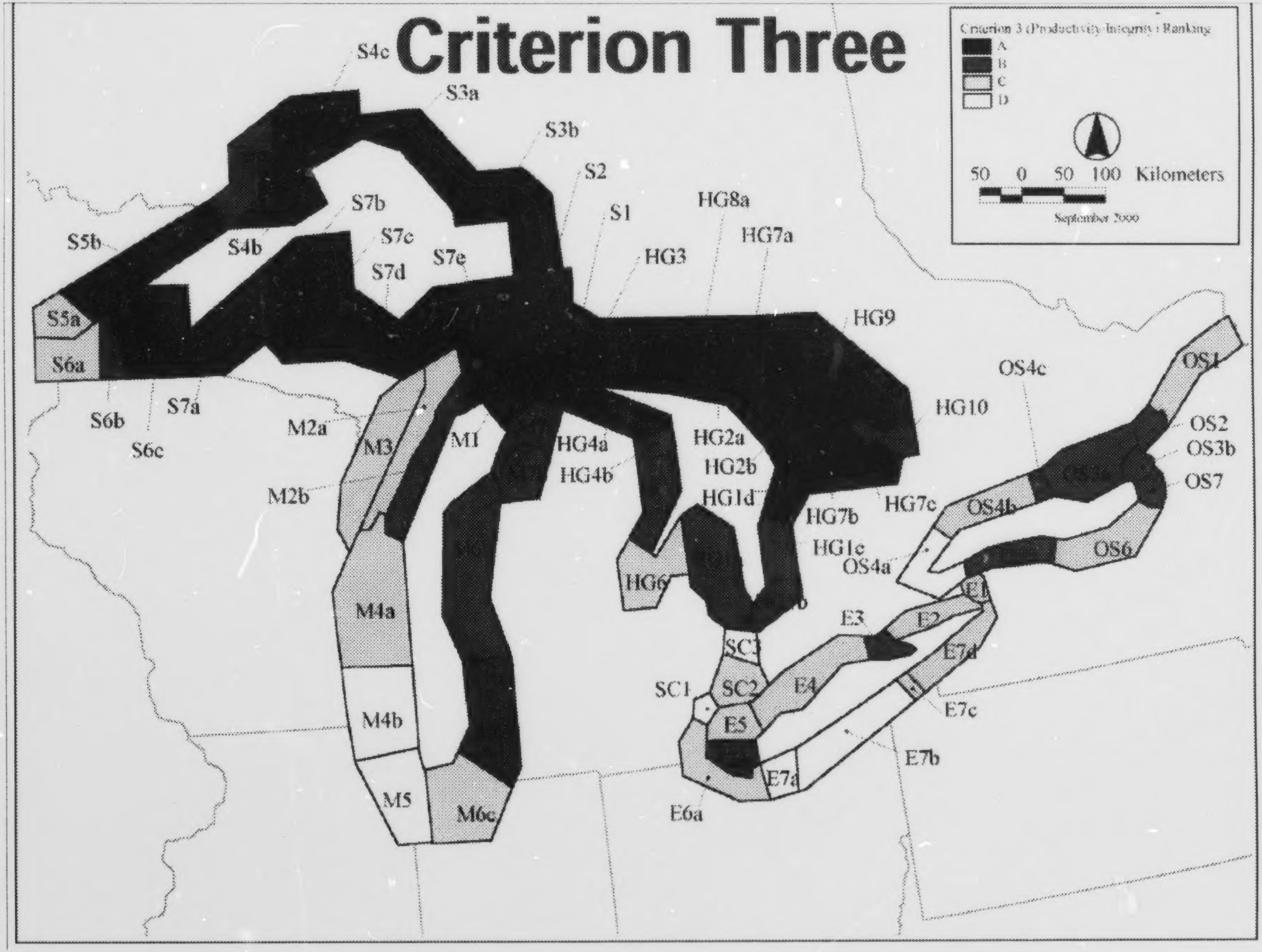
Data sets for Criterion 3
Productivity and Integrity

- Percentage of shoreline hardened

- Trophic degradation of nearshore waters

- Historic wetland loss

Criterion Three

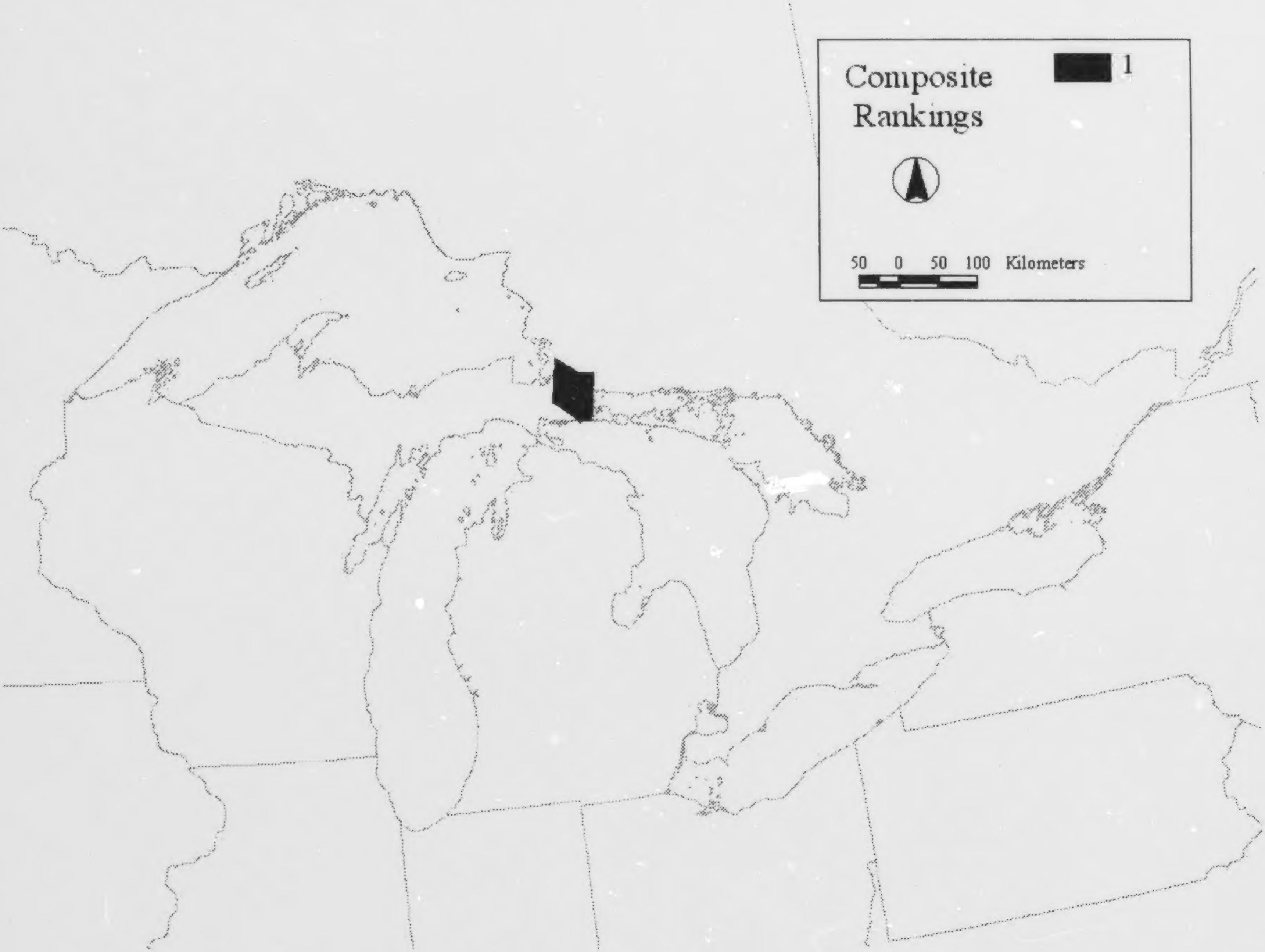

Criterion 3 (Productivity-Integrity) Ranking
A
B
C
D
50 0 50 100 Kilometers
September 2000
S4c
S3a
S3b
S2
S1
HG8a
HG7a
HG3
HG9
S5b
S4b
S7b
S7c
S7d
S7e
S5a
S6a
S6b
S6c
S7a
M2a
M2b
M3
M1
HG4a
HG4b
HG2a
HG2b
HG1d
HG7b
HG7c
HG1c
HG10
OS4c
OS1
OS2
OS3b
OS7
OS4b
OS6
OS4a
HG6
M4a
M4b
M5
M6c
SC3
SC2
SC1
E5
E6a
E7a
E4
E3
E2
E1
E7d
E7c
E7b

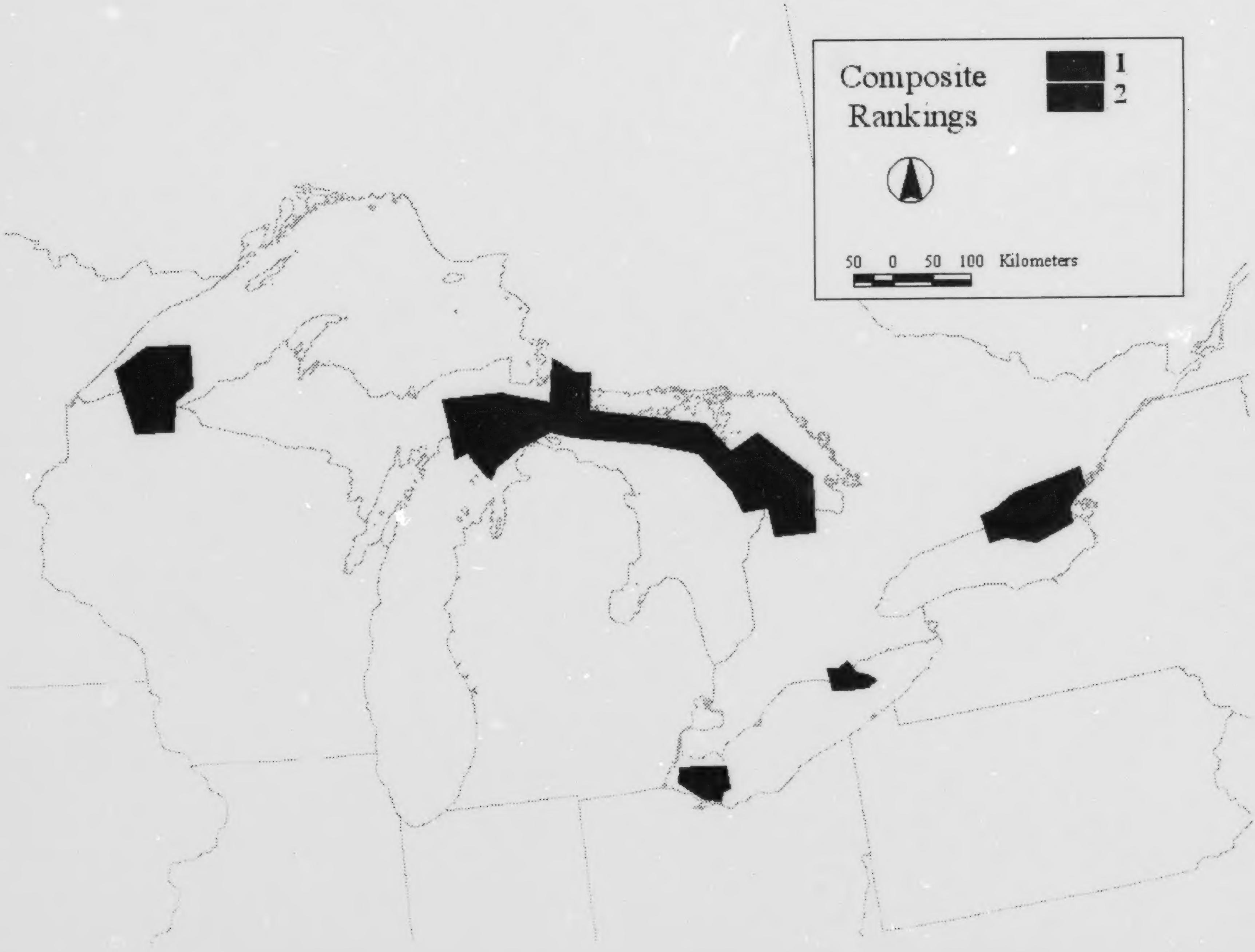
Integration Process
Step Four: Composite Rankings

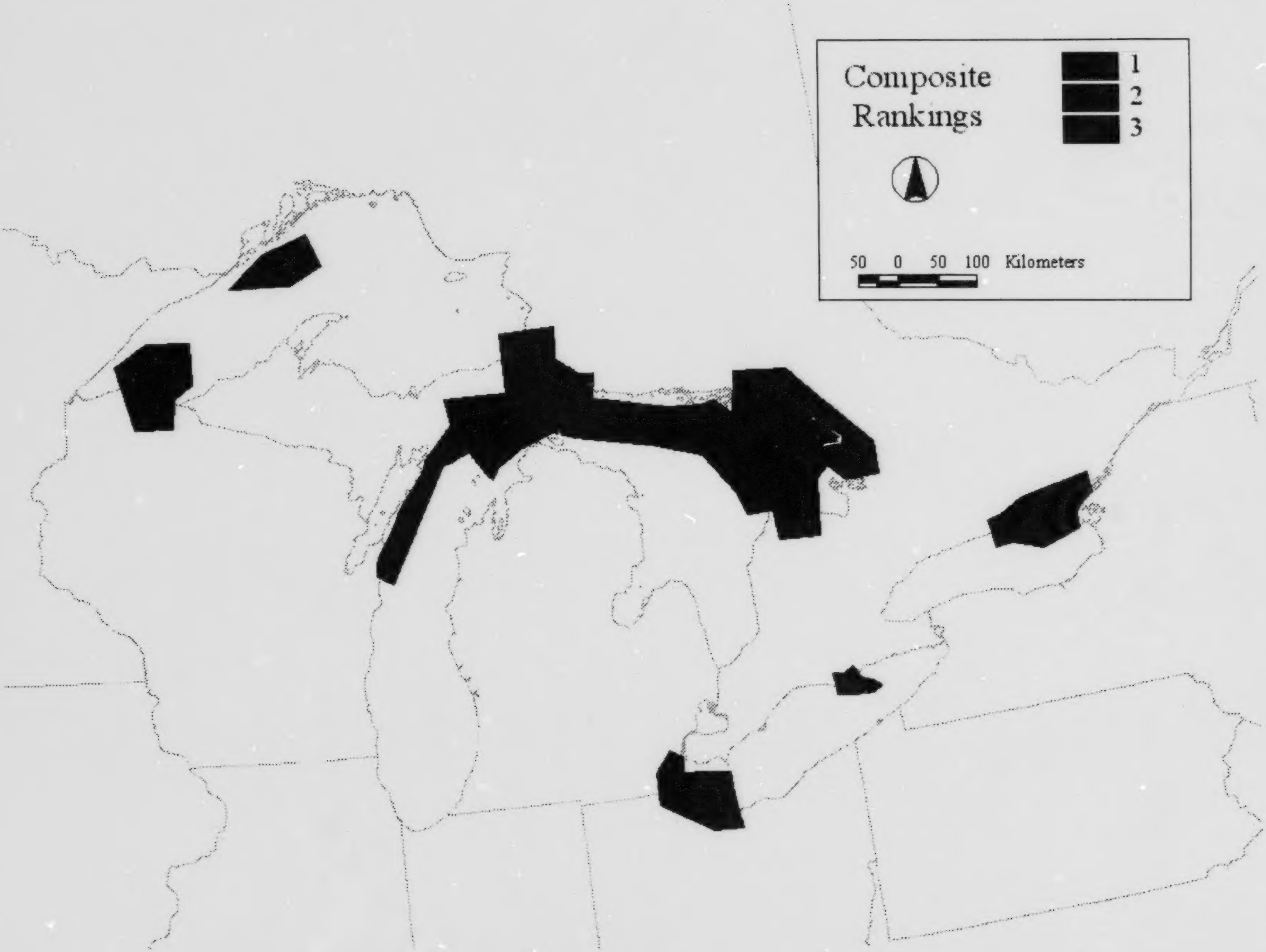
- Overlay rankings for all 3 criteria

- Areas with highest composite ranks

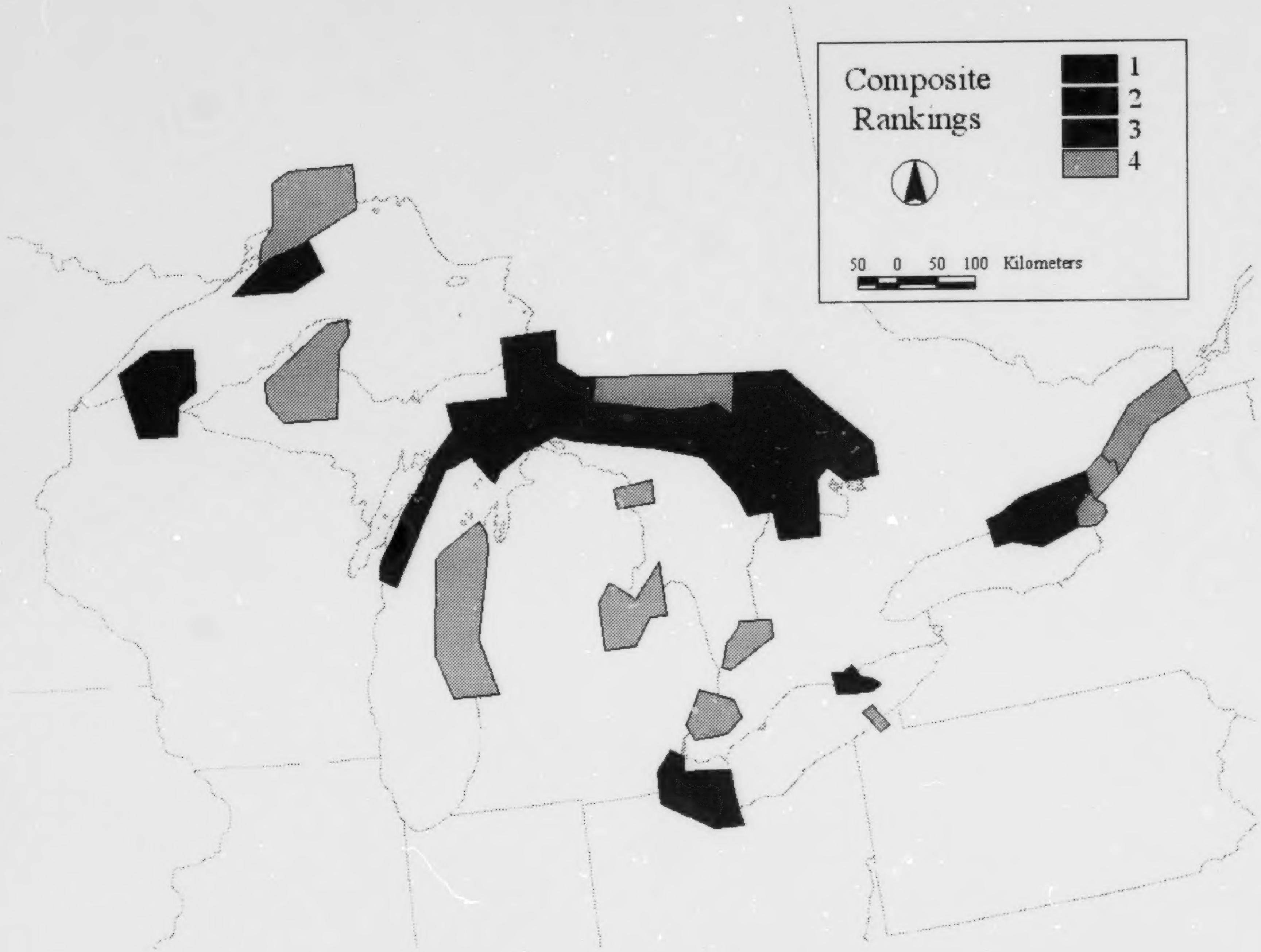
=> potential BIAs

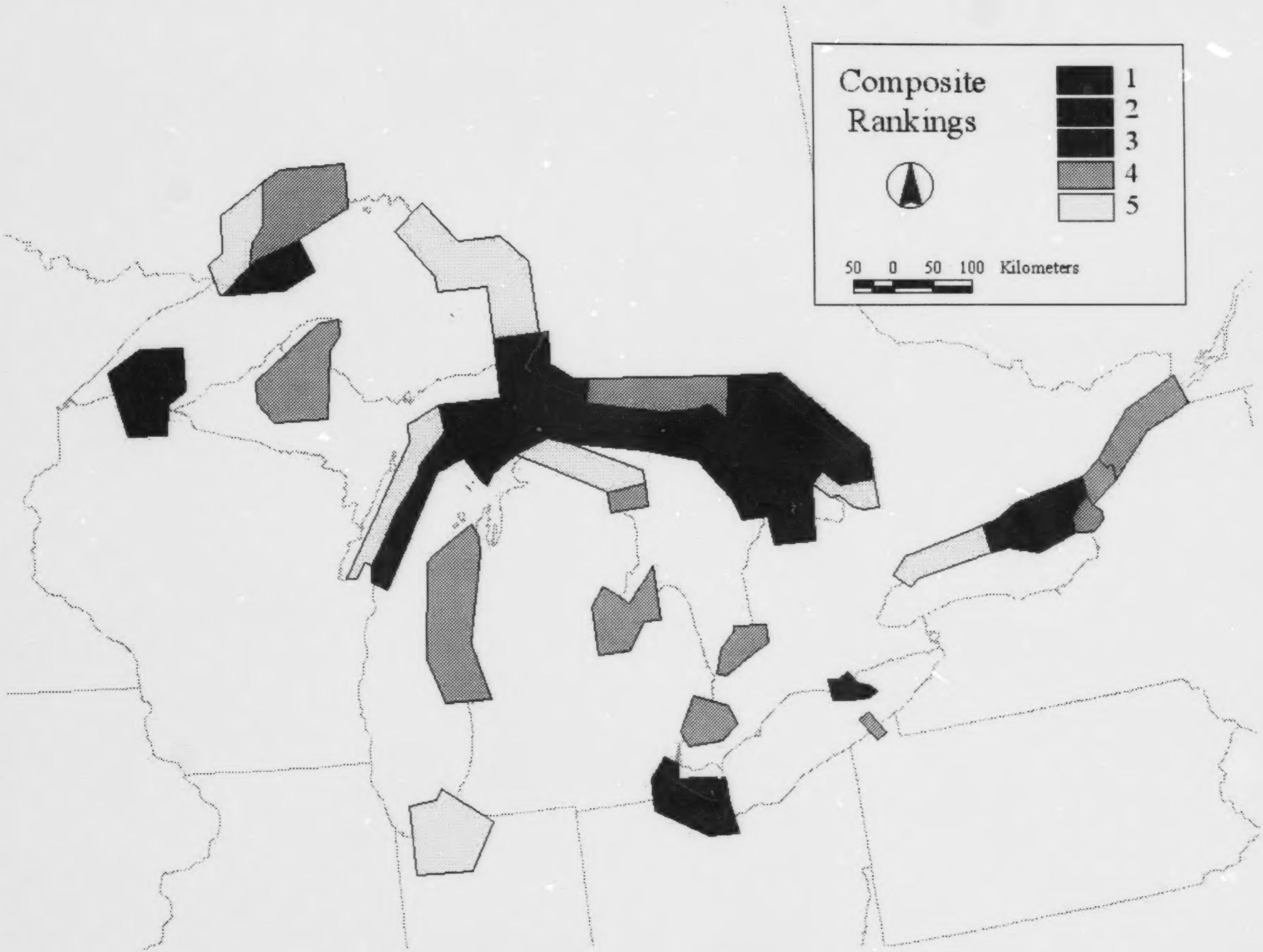

Composite Rankings
1
50 0 50 100 Kilometers

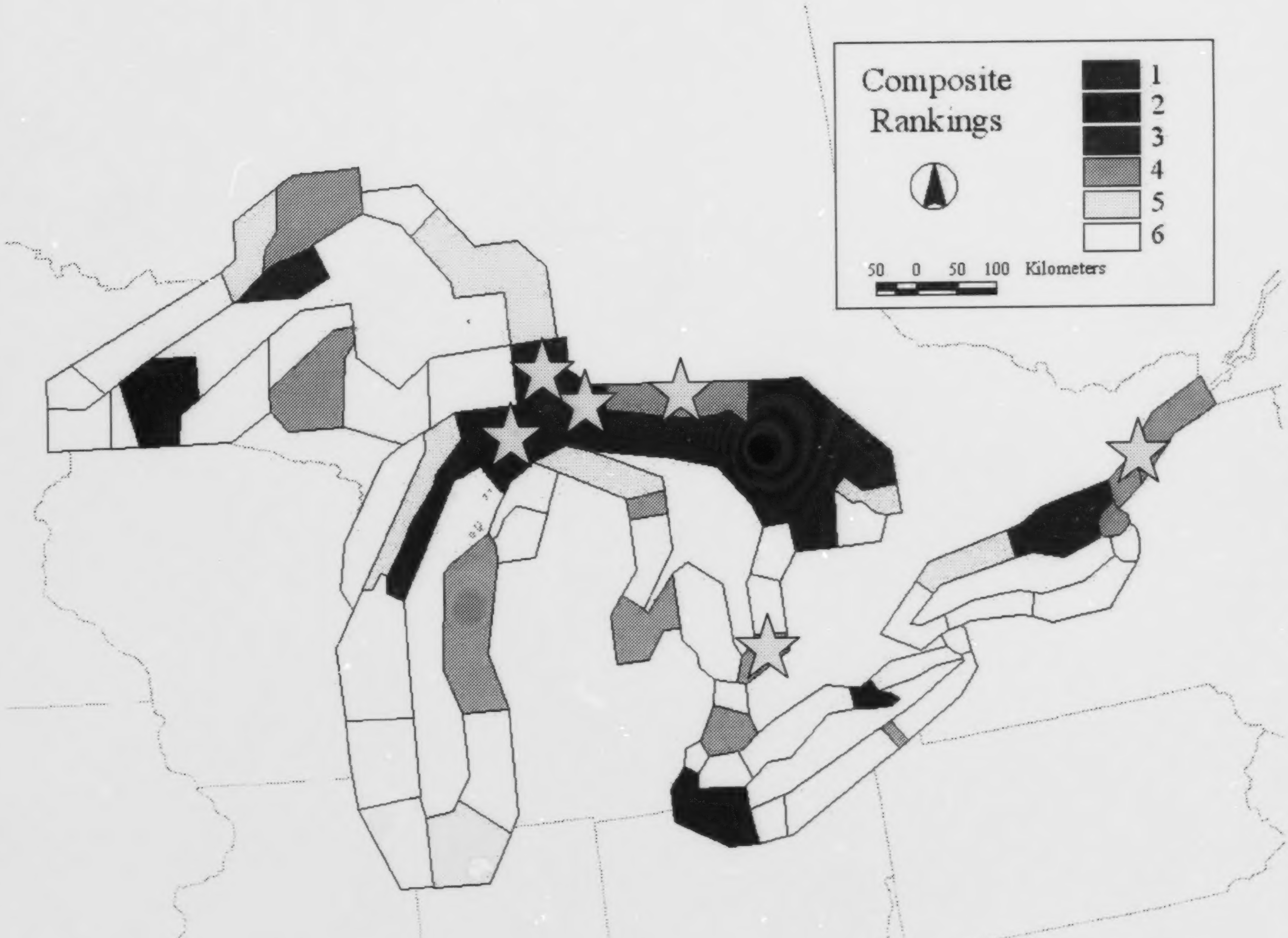

Composite Rankings
1
2
50 0 50 100 Kilometers



Composite
Rankings
1
2
3
50 0 50 100 Kilometers


Composite
Rankings
1
2
3
4
50 0 50 100 Kilometers


Composite
Rankings
1
2
3
4
5
50 0 50 100 Kilometers


Composite
Rankings
1
2
3
4
5
6
50 0 50 100 Kilometers

Case Studies

Long Point -
Lake Erie

Western
Lake Superior

Les Cheneaux
Lake Huron

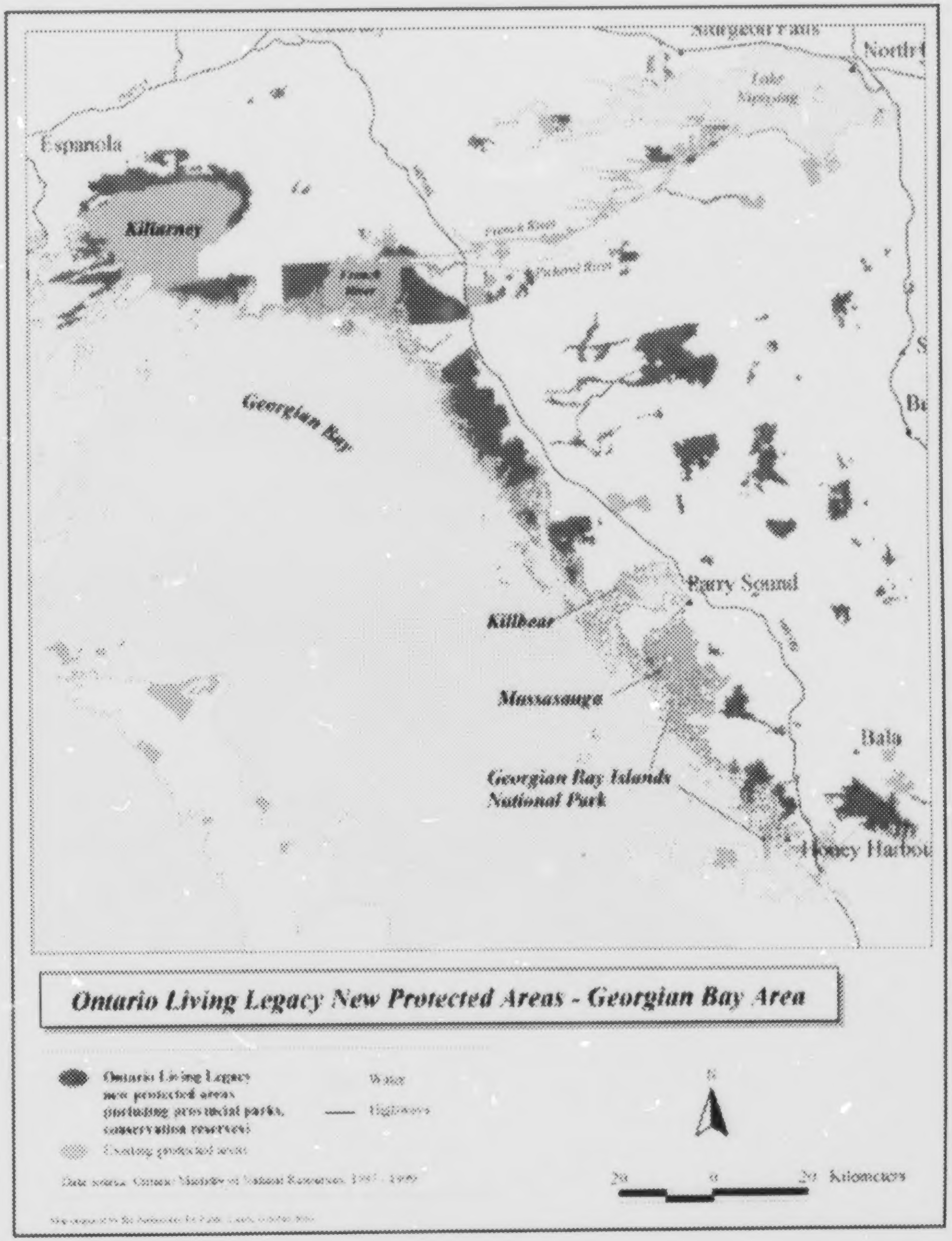
Integrated BIAs: Stressors

- Changing land use
- Non-native species
- Climate change

Integrated BIAs: Successes

- Georgian Bay - Littoral Biosphere Reserve
- Door Peninsula - Stewardship Council
- Manitoulin Island - collaborative land purchase

Ontario Living Legacy Heritage Coast

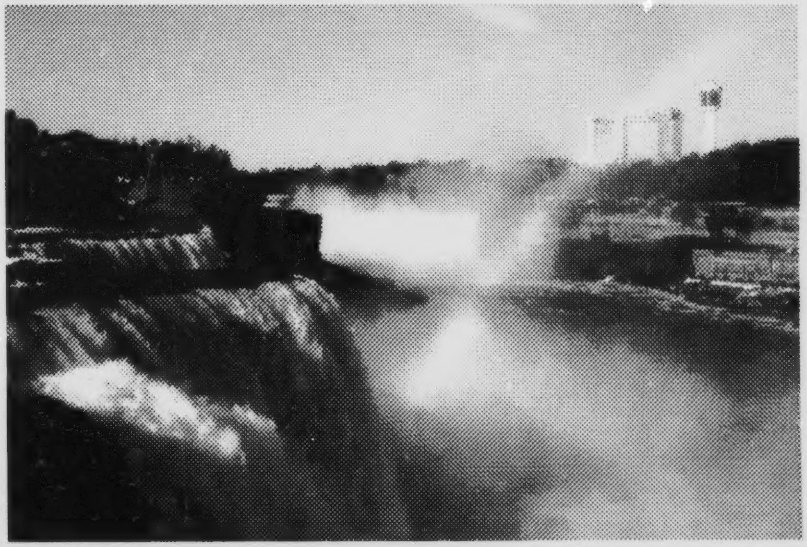

Espanola
Killarney
Sturgeon Falls
Lake Nipissing
French River
Pickerel River
Georgian Bay
Parry Sound
Killbear
Massasauga
Georgian Bay Islands National Park
Bala
N
20
0
20 Kilometers
Water
Highways

Ontario Living Legacy New Protected Areas - Georgian Bay Area

- ● Ontario Living Legacy new protected areas (including provincial parks, conservation reserves)
- ▨ Existing protected areas

Data source: Ontario Ministry of Natural Resources, 1997 - 1999

Biodiversity Investment Areas



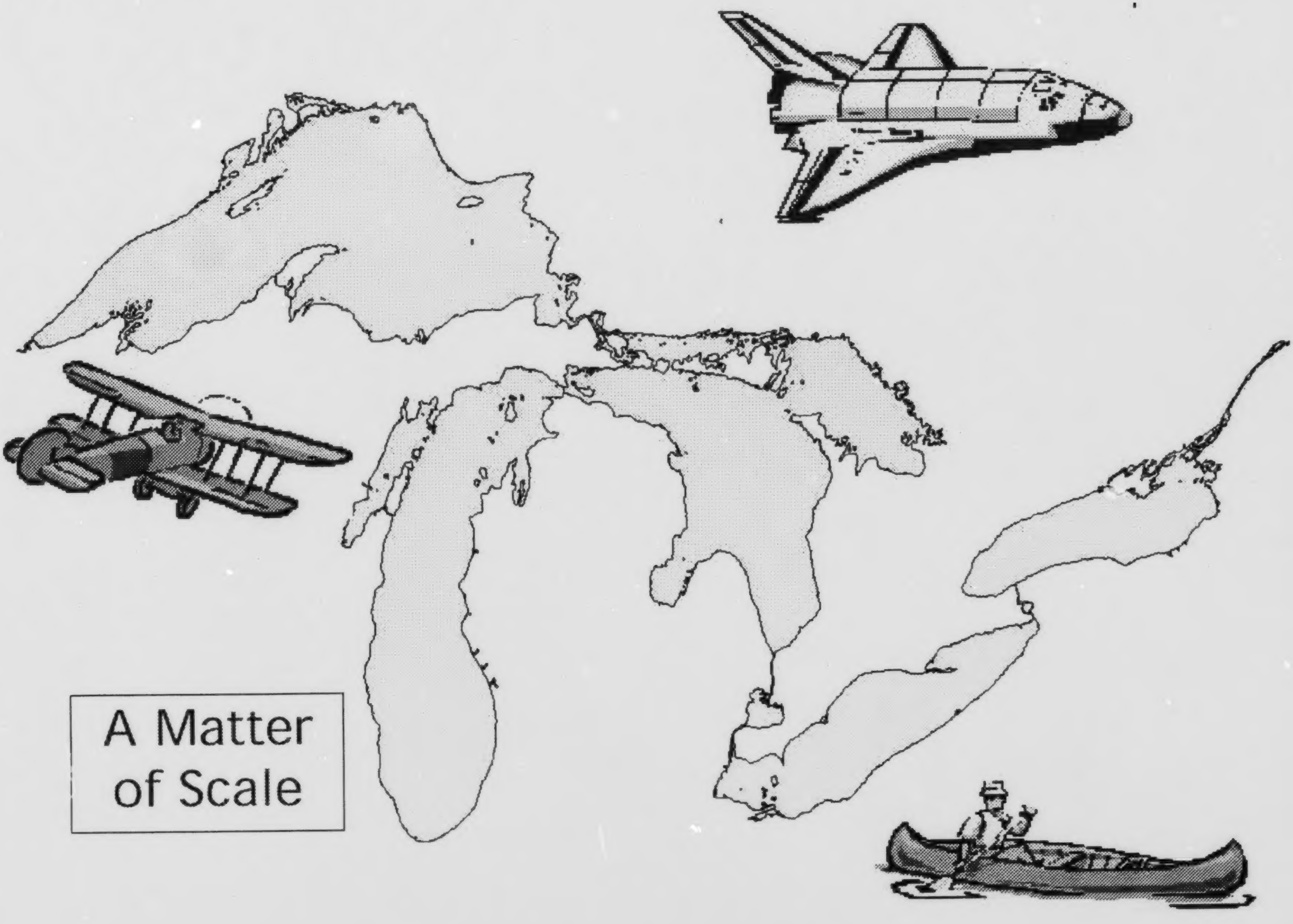
Maintaining...
Key Habitat Areas
Protecting...
Shoreline Habitats

Biodiversity Investment Areas

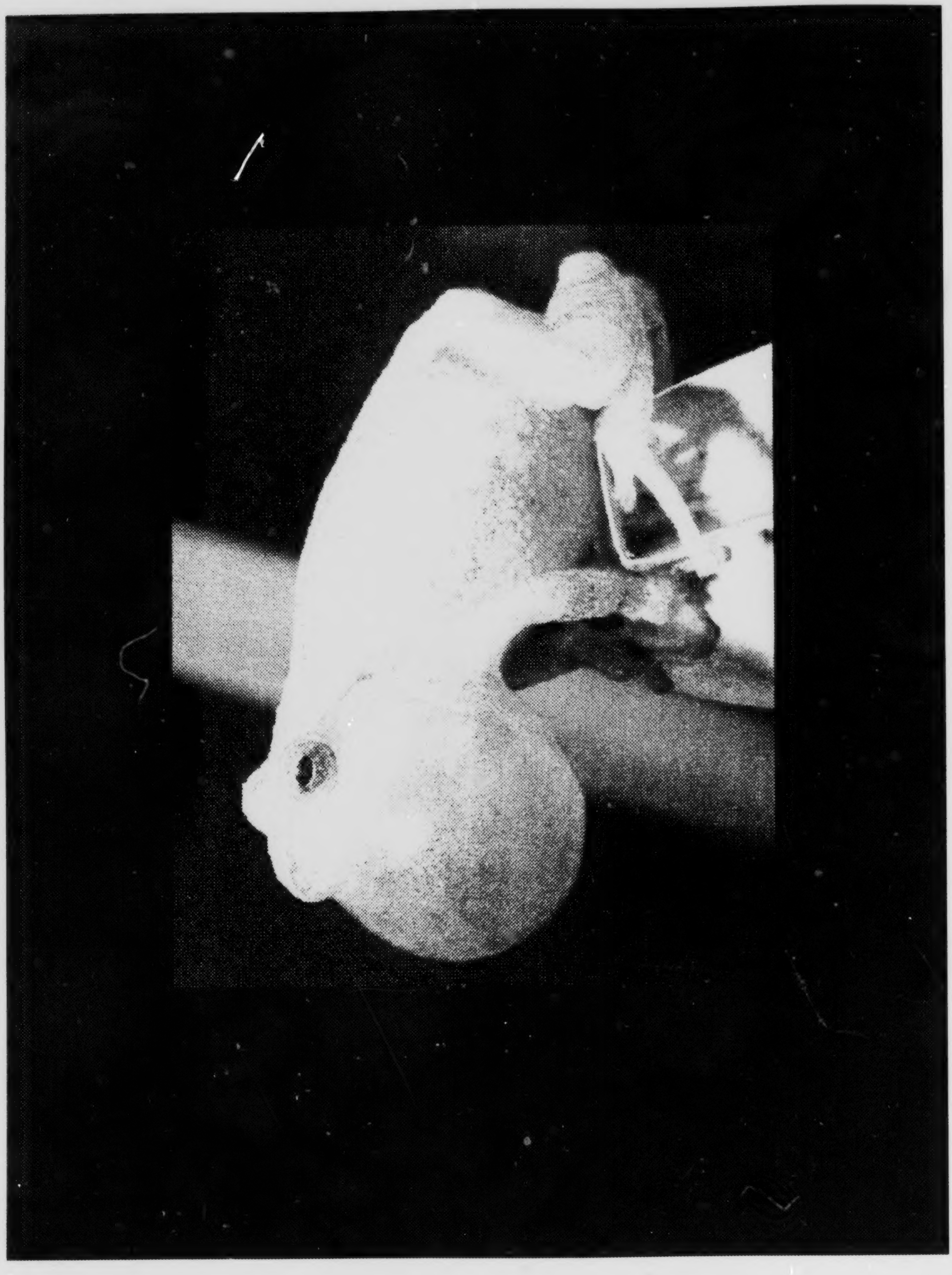
The Challenge

Putting Indicators to Use

Nancy Stadler-Salt
Environment Canada



A Matter of Scale



Today

Putting Indicators to Use in 5 Case Studies

Recognition of 7 Successful Initiatives

Case Studies

- Hamilton Harbour
- Chicago Wilderness
- Marsh Monitoring Program
- International Alvar Conservation Initiative
- Contemporary Wild Rice Management

Success Stories

- Tip of the Mitt Watershed Council
- Xerox: A Waste Free Company
- Hamilton Harbour Area of Concern
- Ontario Power Generations' Carbon Sequestration & Biodiversity Management Plan
- Rural Water Quality Program
- Saginaw Bay Watershed Initiative Network
- Ontario's Environmental Farm Plan

SOLEC 2000

Putting Indicators to Use

Hamilton Harbour Remedial Action Plan

Presented by: John D. Hall, M.C.I.P., R.P.P.

Prepared by:

John D. Hall, RAP Coordinator

Kathy Trotter, RAP Administrative Assistant

Murray Charlton, Chair RAP Technical Team, Environment Canada

Mark Sproule-Jones, President, Bay Area Restoration Council

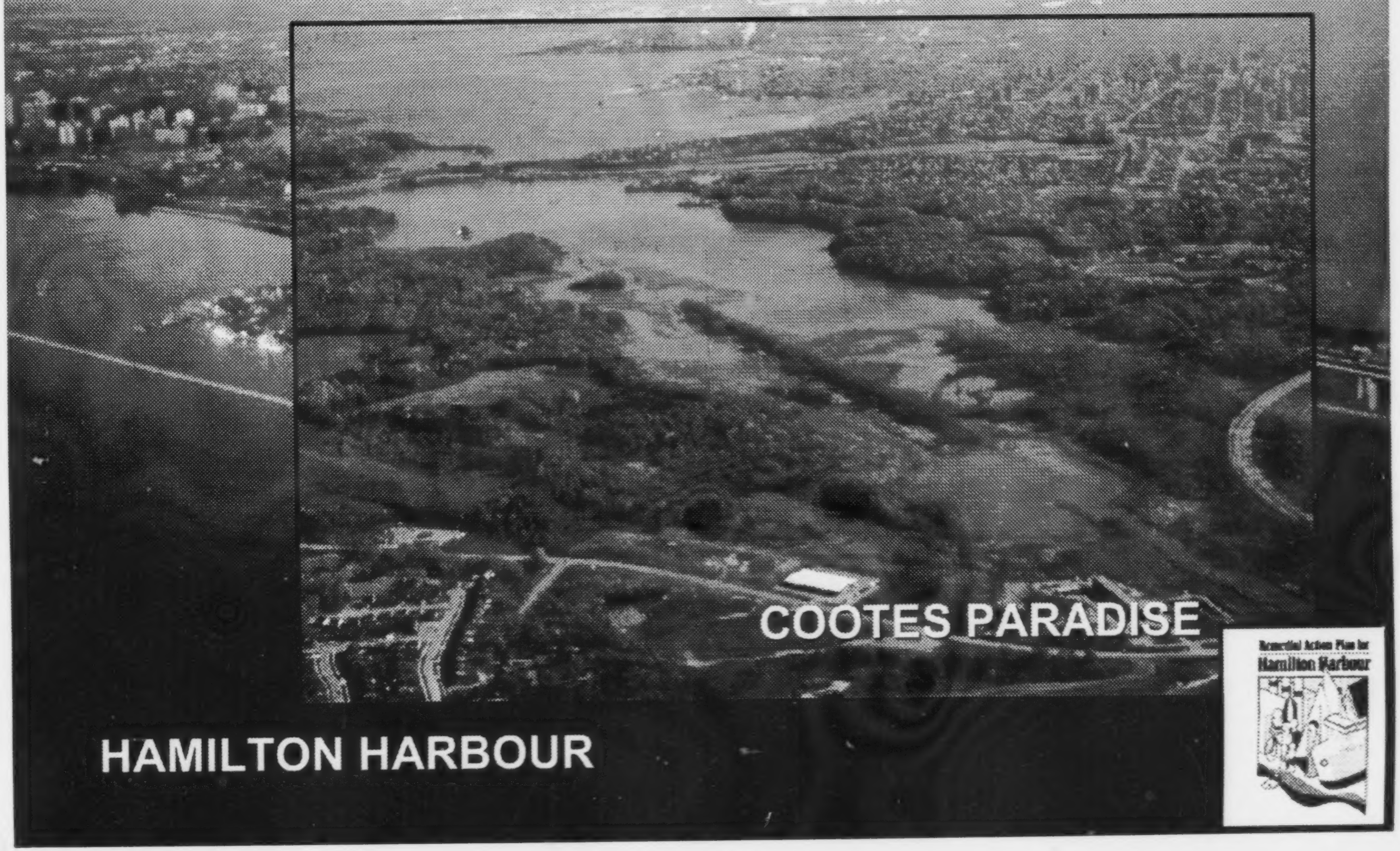
Marilyn Baxter, Manager, Bay Area Restoration Council

Anne Redish, Chair, RAP Forum

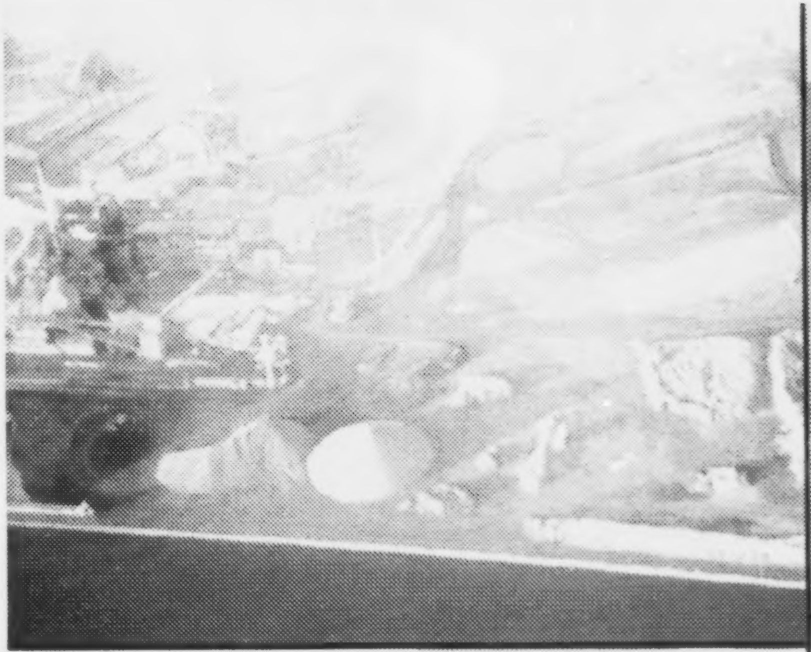
OCTOBER, 2000

Remedial Action Plan for
Hamilton Harbour

Hamilton Harbour
Remedial Action Plan

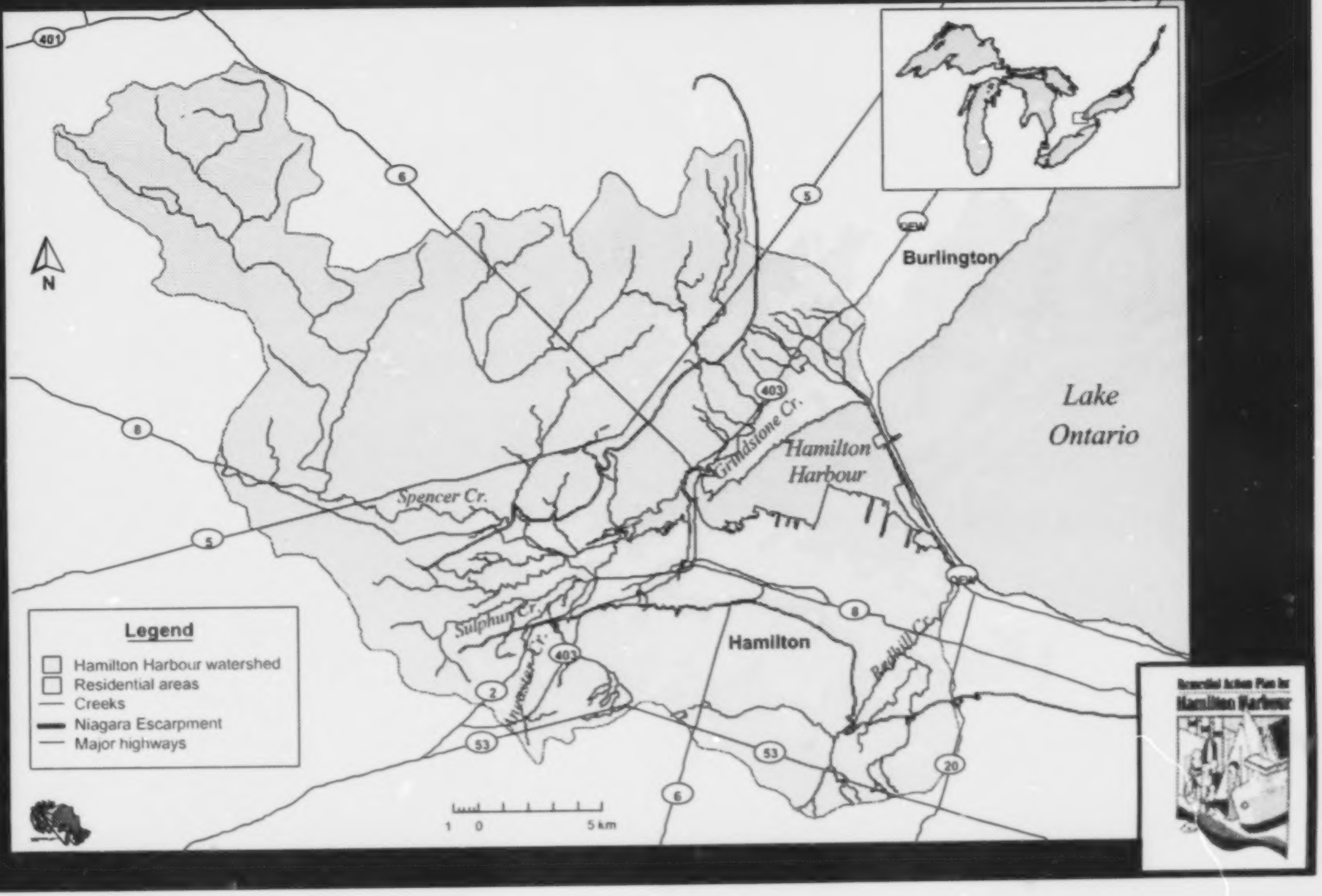

COOTES PARADISE
HAMILTON HARBOUR

Remedial Action Plan for Hamilton Harbour

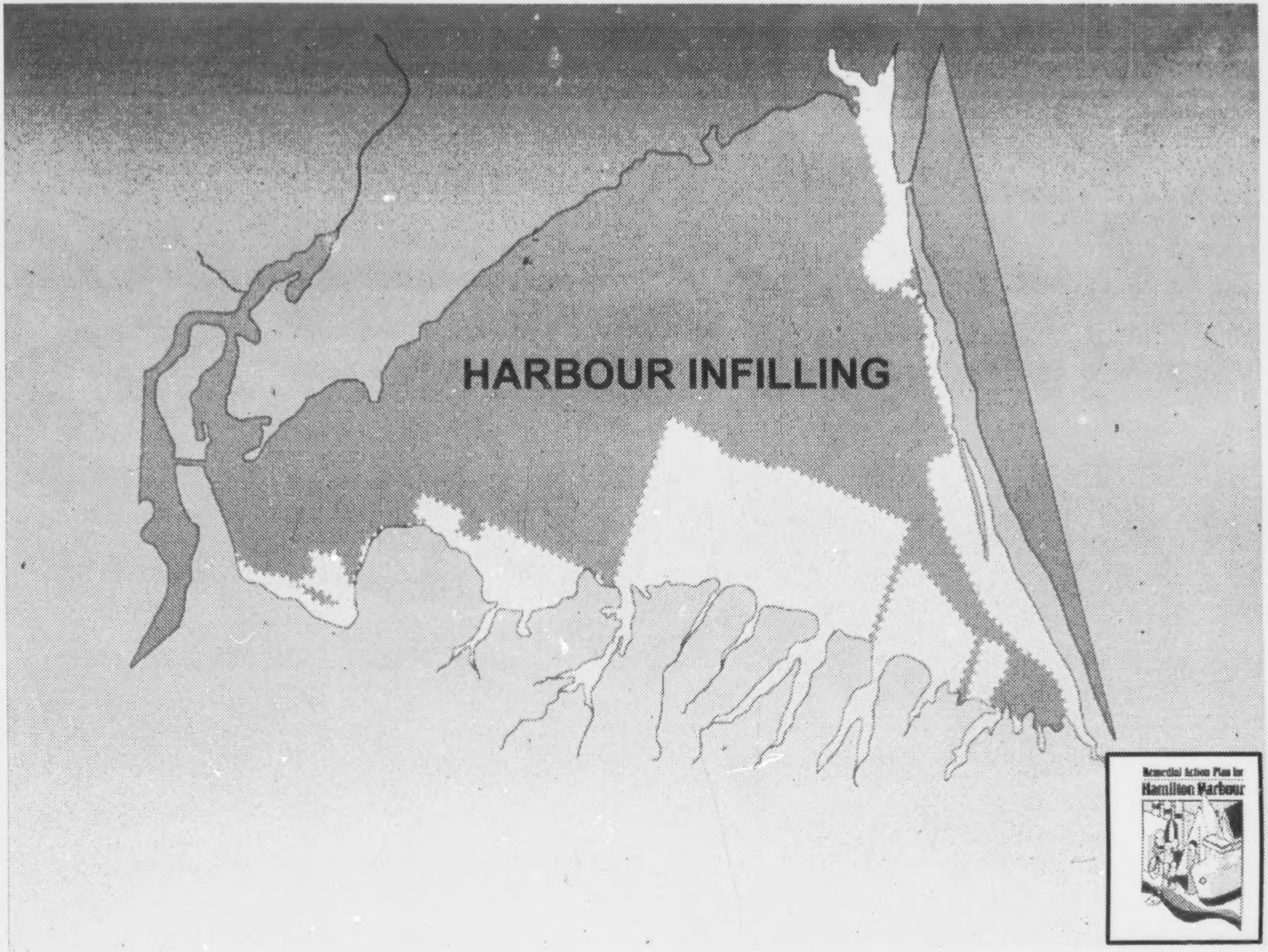


Remedial Action Plan for
Hamilton Harbour

Hamilton Harbour Watershed

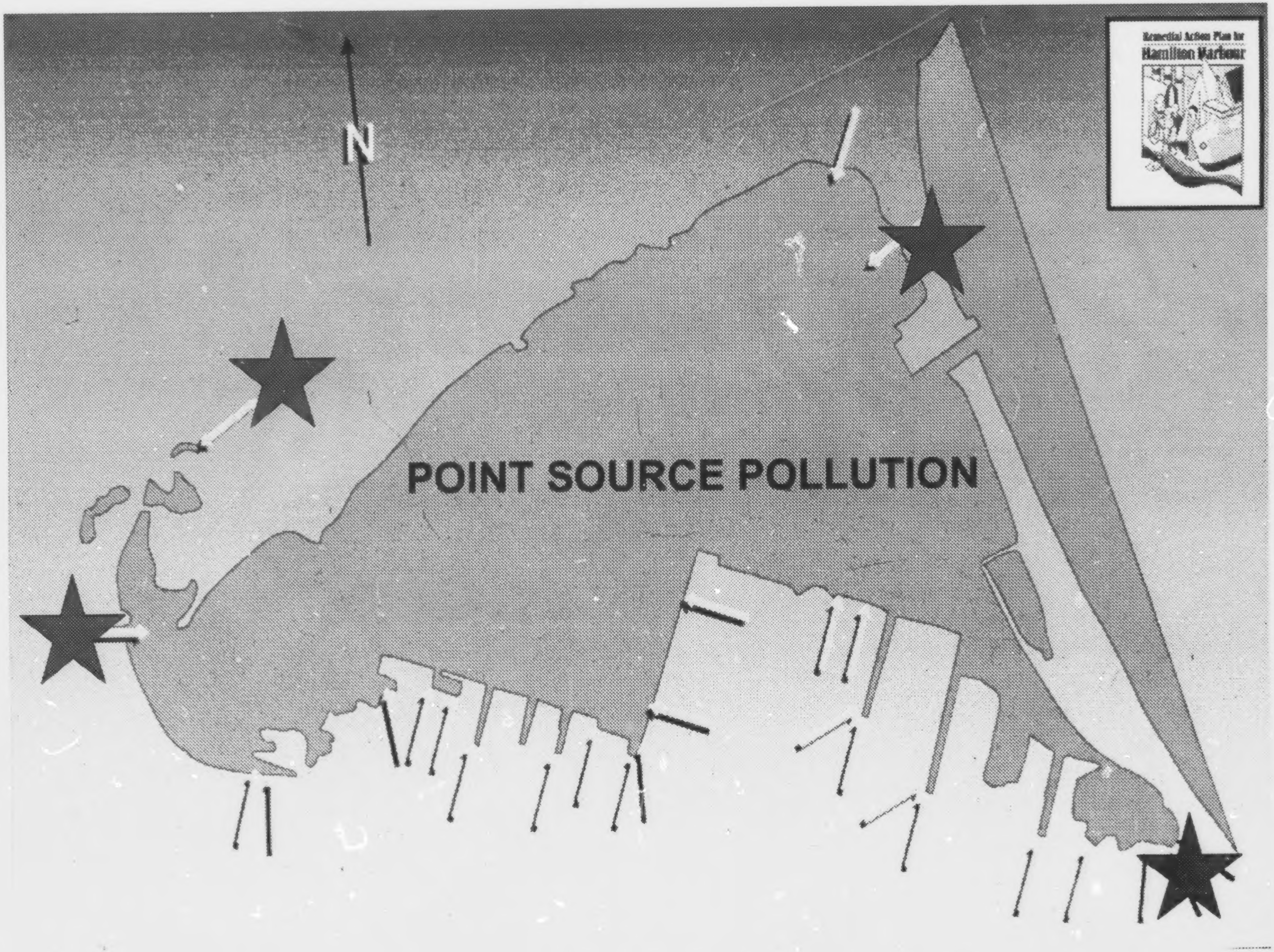

Legend
Hamilton Harbour watershed
Residential areas
Creeks
Niagara Escarpment
Major highways
N
1 0 5 km
Lake Ontario
Burlington
Hamilton Harbour
Hamilton
Grindstone Cr.
Spencer Cr.
Sulphur Cr.
Ancaster Cr.
Redhill Cr.
401
6
5
8
403
QEW
2
53
20
Remedial Action Plan for Hamilton Harbour

HARBOUR INFILLING

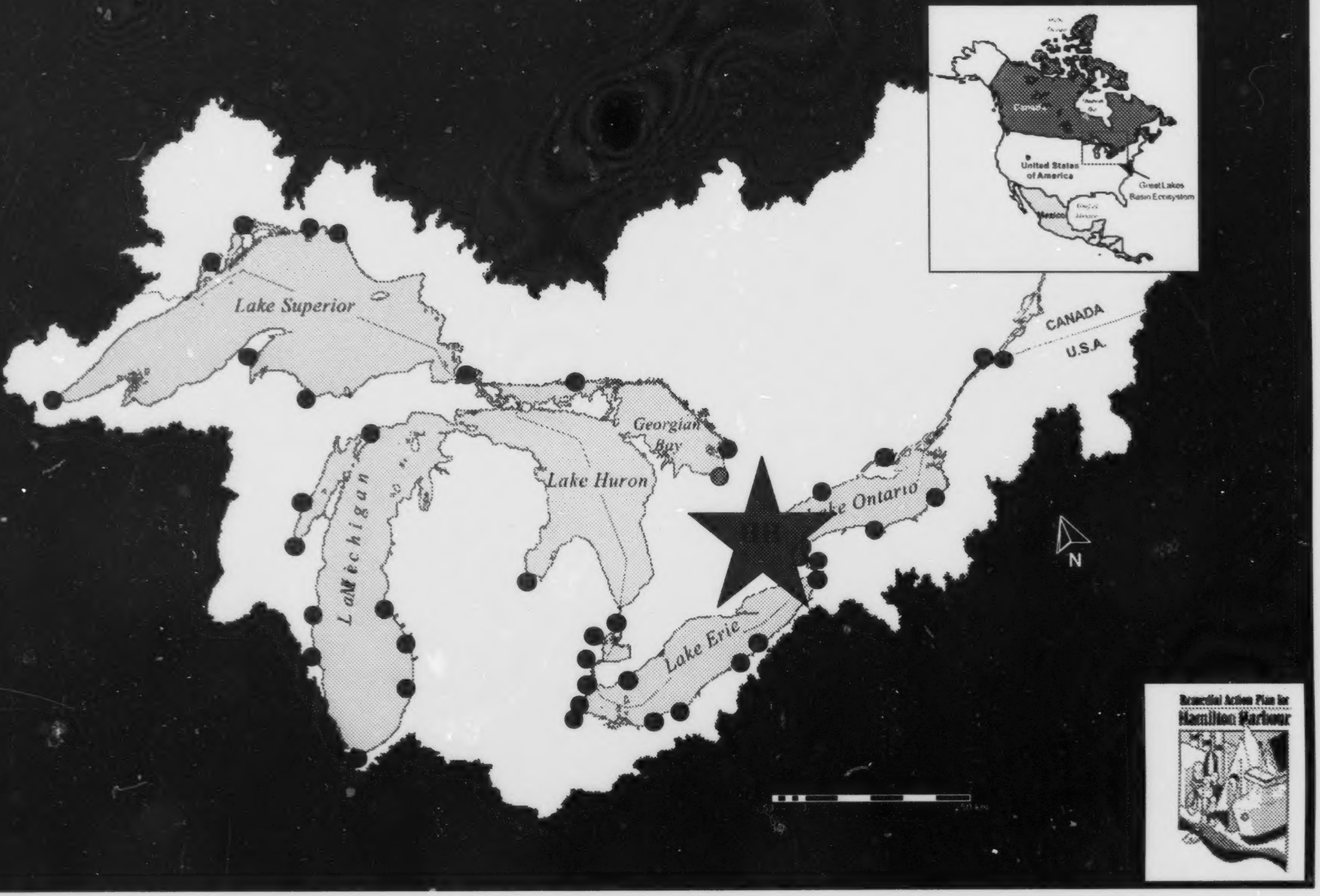


Remedial Action Plan for
Hamilton Harbour

POINT SOURCE POLLUTION


N
Remedial Action Plan for
Hamilton Harbour

Great Lakes Areas of Concern


Lake Superior
Lake Michigan
Lake Huron
Georgian Bay
Lake Ontario
Lake Erie
HH
CANADA
U.S.A.
N
Canada
United States of America
Great Lakes Basin Ecosystem
Mexico
Remedial Action Plan for
Hamilton Harbour

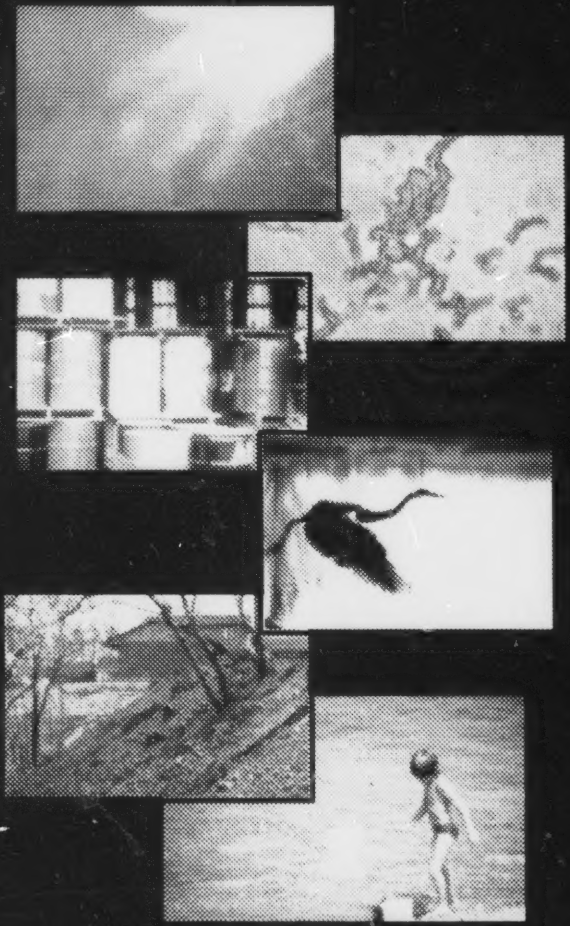
Areas of Concern

- Identified under the GLWQA
- Delisting criteria defined

- State of Environment “Stage 1 Report”
- Remedial Action Plan “Stage 2 Report”
- Delisting of AOC “Stage 3 Report”

Remedial Action Plan for Hamilton Harbour

HAMILTON HARBOUR
Remedial Action Plan

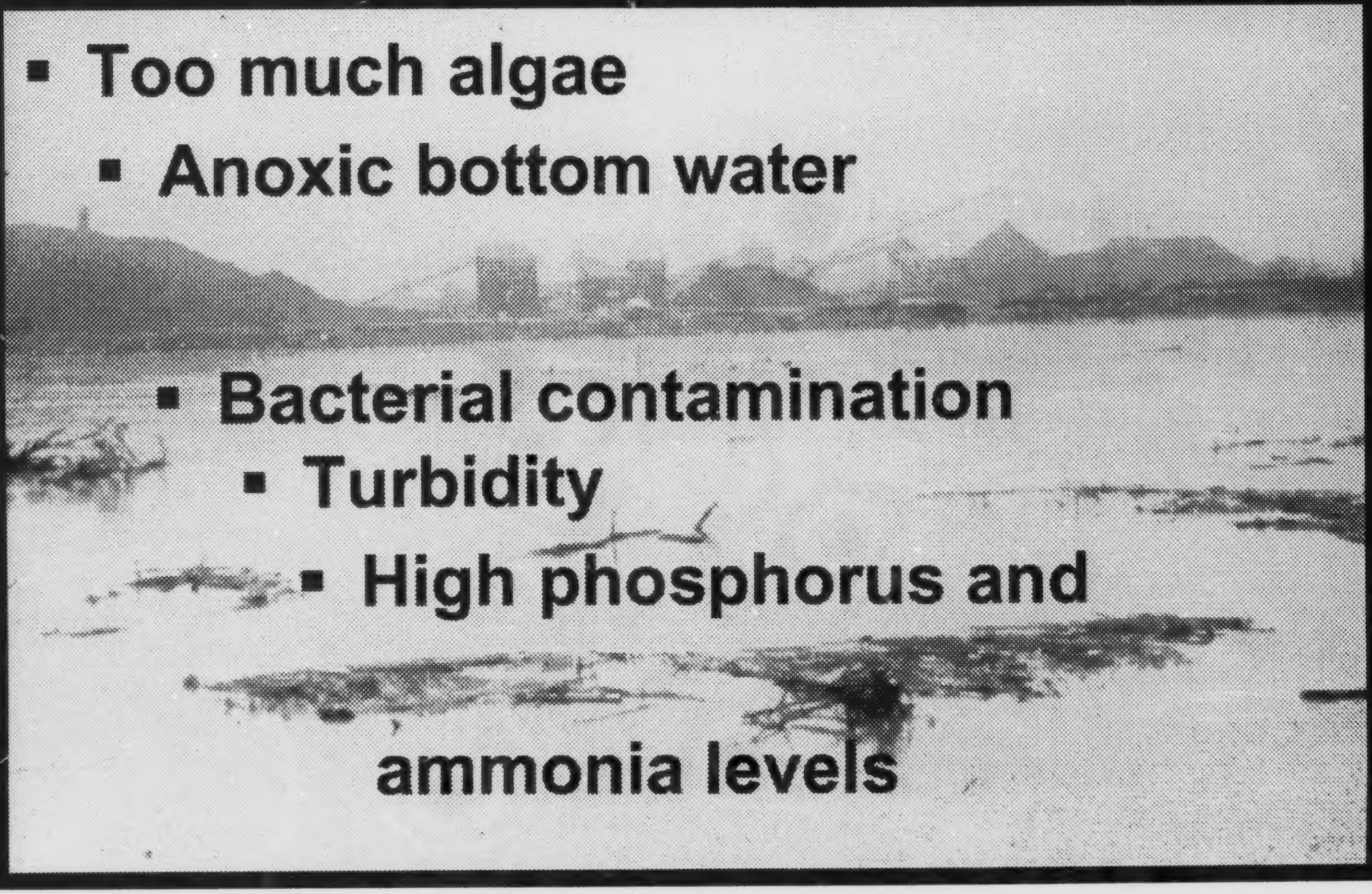


1. Water Quality and Bacterial Contamination
2. Toxic Contaminants
3. Fish and Wildlife Habitat Restoration
4. Urbanization and Land Management
5. Public Access and Aesthetics

Remedial Action Plan for
Hamilton Harbour

1. Water Quality and Bacterial Contamination

Problems:



- Too much algae
  - Anoxic bottom water
    - Bacterial contamination
      - Turbidity
        - High phosphorus and ammonia levels

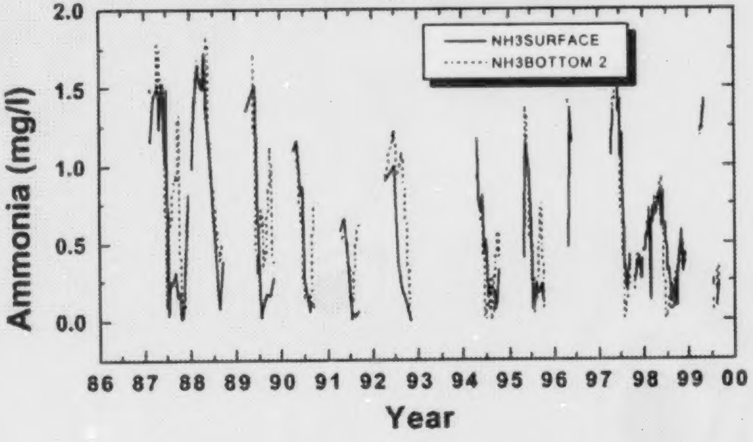
Remedial Action Plan for
Hamilton Harbour

1. Water Quality and Bacterial Contamination

Goals:

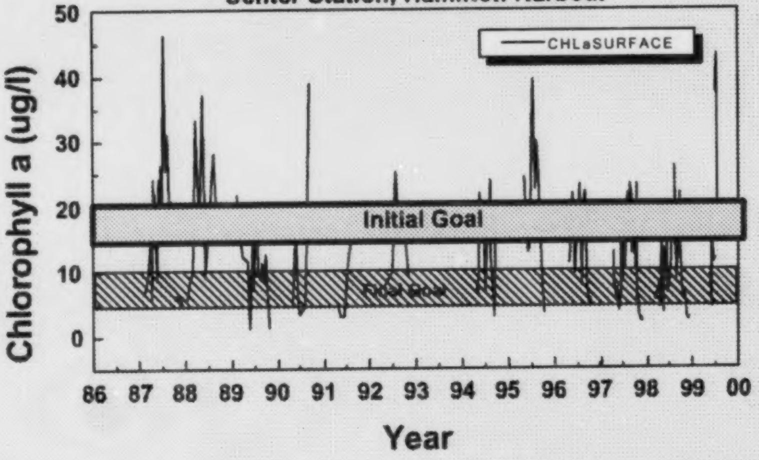
	Initial	*Final*
▪ Phosphorus	34 ug/l	17 ug/l
▪ Chlorophyll	15-20 ug/l	5-10 ug/l
▪ Transparency	2 m	3 m
▪ Bacteria	<100fc/100ml	<100fc/100ml

Ammonia
Center Station, Hamilton Harbour



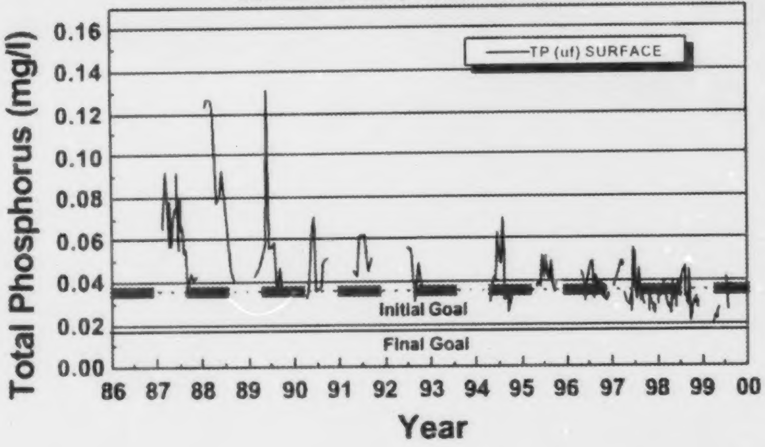
Murray N. Charlton NWRI

Chlorophyll a
Center Station, Hamilton Harbour



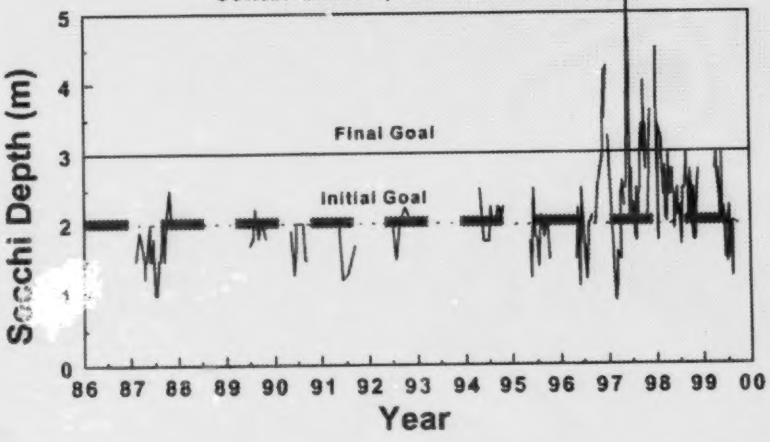
Murray N. Charlton NWRI

Total Phosphorus un-filtered
Center Station, Hamilton Harbour



Murray N. Charlton NWRI

Secchi Depth
Center Station, Hamilton Harbour



Murray N. Charlton NWRI

1. Water Quality and Bacterial Contamination

Emerging Issues:

- Population growth requires more sewage treatment.
- Blue-green algae becoming more common - some produce toxins
- Endocrine disrupting substances and pharmaceuticals in treated sewage.

Remedial Action Plan for
Hamilton Harbour

2. Toxic Contaminants

Problem:

- Legacy of past abuses buried in sediments (metals, PCBs, PAHs)
- PCBs in water are high relative to Lake Ontario
- Airborne contaminants

Remedial Action Plan for
Hamilton Harbour

2. Toxic Contaminants

Goals:

- Clean up Randle Reef and other hot spots
- Find and eliminate toxic contaminants sources

2. Toxic Contaminants

Progress:

- Reductions in heavy metals
- Reductions in PAHs and PCBs

★ Still waiting to clean up Randle Reef…

Remedial Action Plan for Hamilton Harbour

2. Toxic Contaminants

Emerging Issues:

- Sewer sources of toxics
- Nitrate from sewage treatment plants may harm Cootes Paradise marsh amphibians

Remedial Action Plan for
Hamilton Harbour

3. Fish & Wildlife Habitat Restoration

The Problem:

- Toxic substances, excessive nutrients and reduced oxygen affect the health of fish and wildlife

Remedial Action Plan for
Hamilton Harbour

3. Fish & Wildlife Habitat Restoration

Goals:

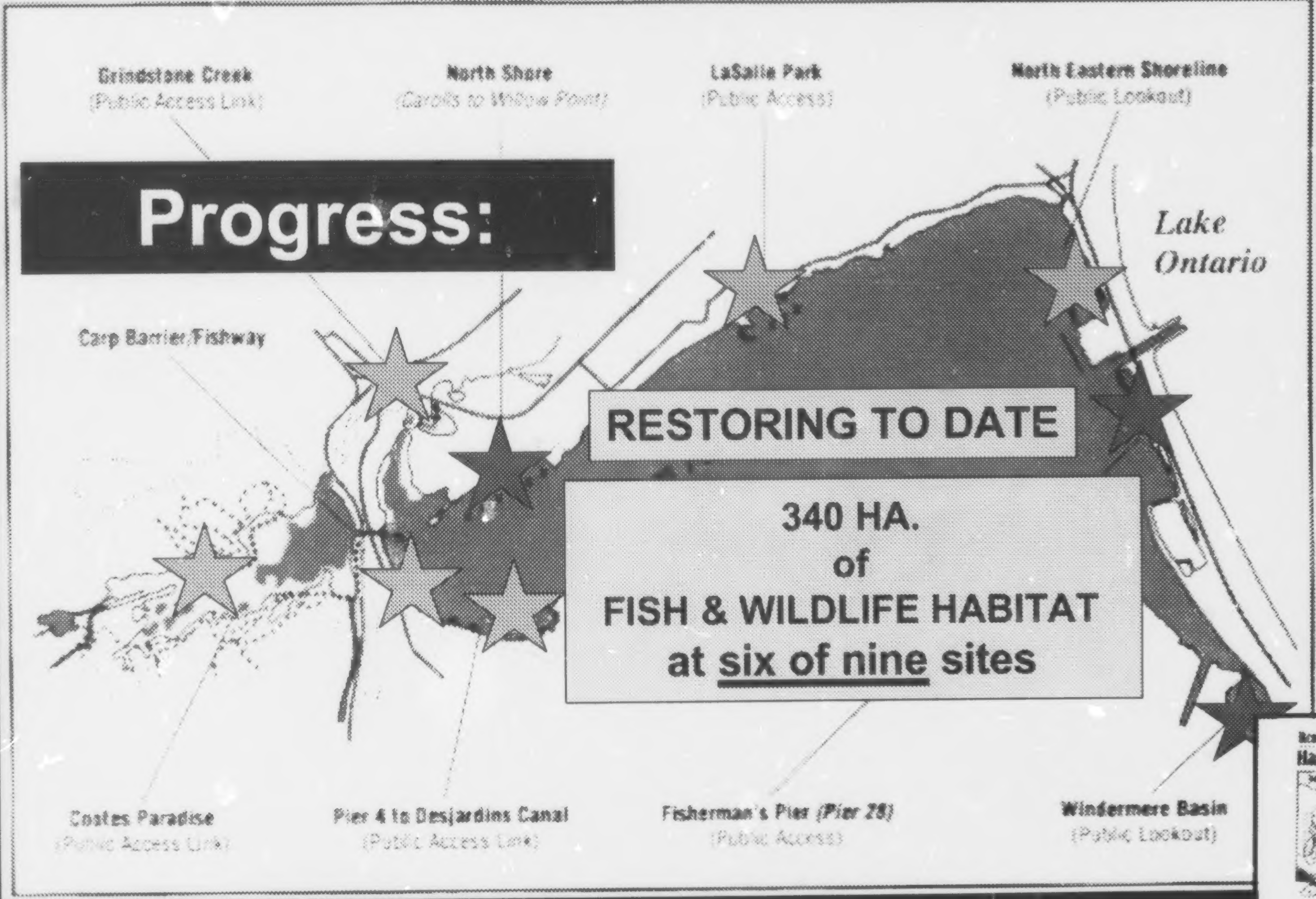
- Edible reproducing warm-water fishery
- Healthy resident and migratory wildlife populations

An ambitious plan was prepared to re-establish:

- *372ha of fish and wildlife habitat at nine sites around the harbour*

Remedial Action Plan for
Hamilton Harbour

3. Fish & Wildlife Habitat Restoration

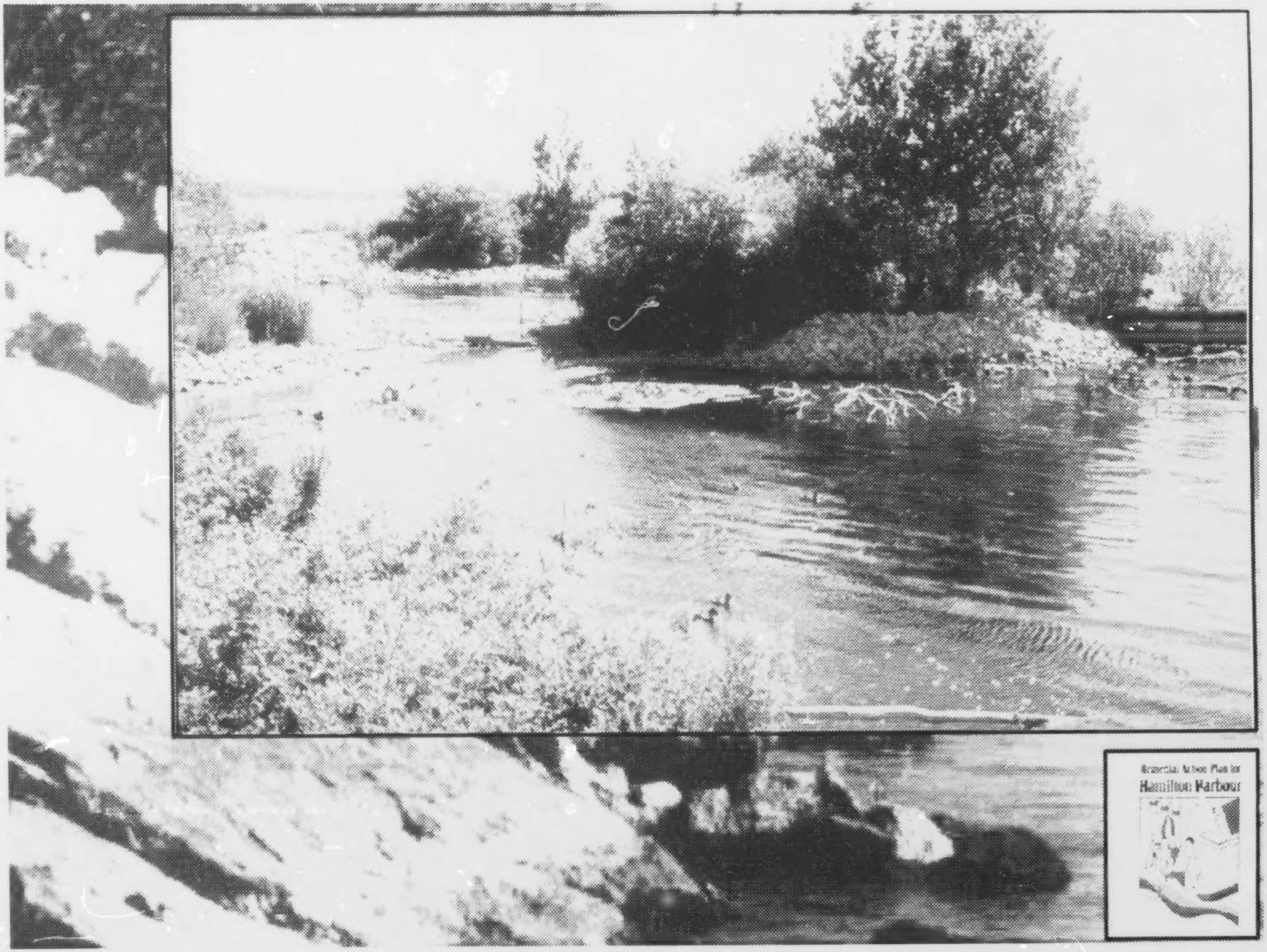

Grindstone Creek
(Public Access Link)
North Shore
(Carolls to Willow Point)
LaSalle Park
(Public Access)
North Eastern Shoreline
(Public Lookout)
Lake Ontario
Carp Barrier/Fishway
Cootes Paradise
(Public Access Link)
Pier 4 to Desjardins Canal
(Public Access Link)
Fisherman's Pier *(Pier 28)*
(Public Access)
Windermere Basin
(Public Lookout)

Progress:

RESTORING TO DATE

340 HA.
of
FISH & WILDLIFE HABITAT
at six of nine sites

Remedial Action Plan for
Hamilton Harbour



Remedial Action Plan for
Hamilton Harbour

3. Fish & Wildlife Habitat Restoration

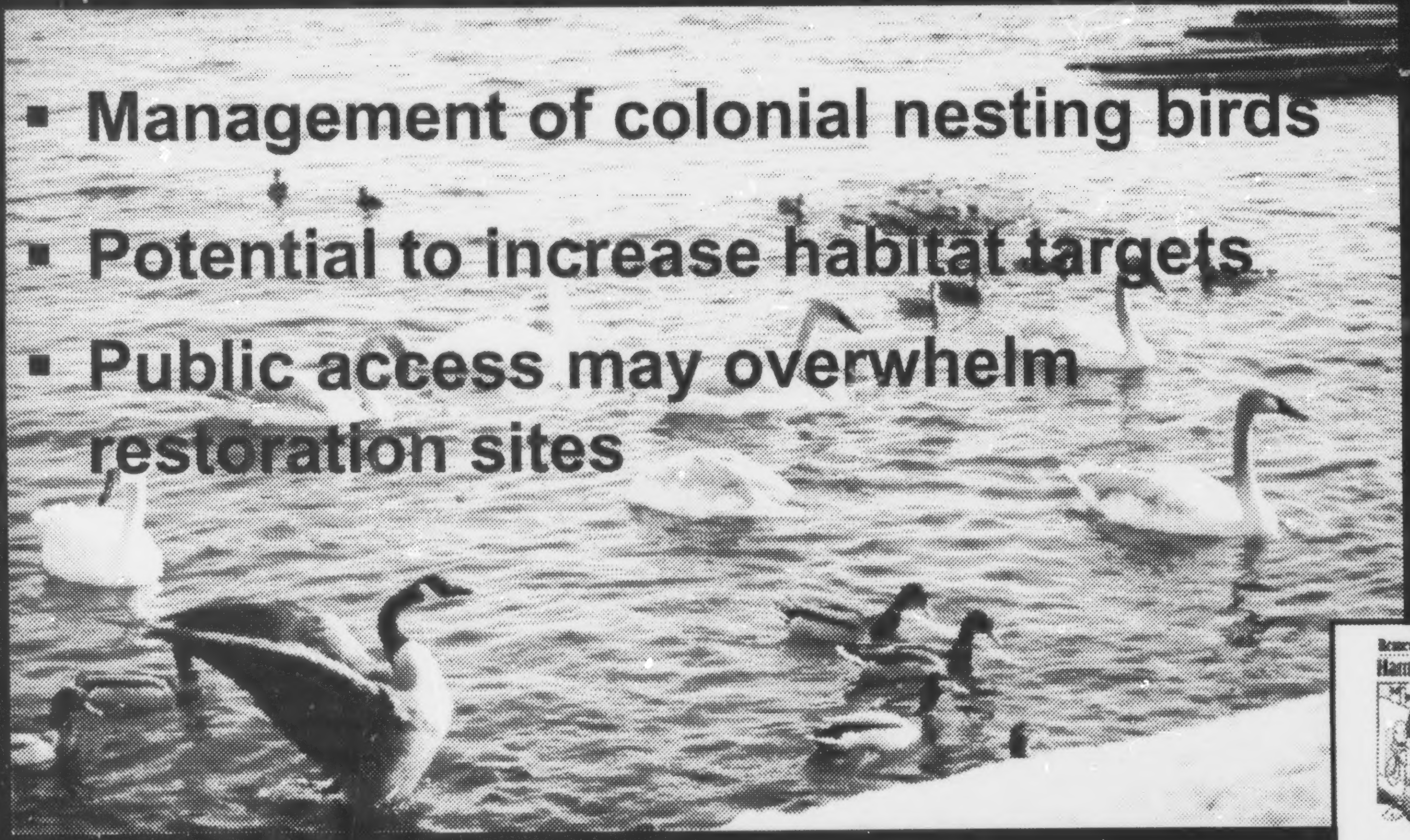
Progress:

- 170ha aquatic plants
- 18 species of plants
- Increased waterfowl diversity
- 670 nesting pairs of Caspian and common terns
- Increases in amphibians

- *little overall change in fishery but dramatic changes at restoration sites*
- *water level regulation of Lake Ontario at odds with marsh restoration*

3. Fish & Wildlife Habitat Restoration

Emerging Issues:



- Management of colonial nesting birds
- Potential to increase habitat targets
- Public access may overwhelm restoration sites

Remedial Action Plan for
Hamilton Harbour

4. Urbanization & Land Management

The Problem:

- Urban sprawl
- Watershed runoff carries contaminants and nutrients

Remedial Action Plan for Hamilton Harbour

4. Urbanization & Land Management

Goal: A sustainable natural ecosystem in Hamilton Harbour and its entire watershed

Remedial Action Plan for
Hamilton Harbour

4. Urbanization & Land Management

Progress:

- Watershed plans
- Watershed stewardship
- Vision 2020, an ecological approach to sustainable development
- Environmental planning

Remedial Action Plan for Hamilton Harbour

4. Urbanization & Land Management

Progress:

- Cleaner sediment now entering Harbour
- Watershed stewardship agreements

Watershed Steward
Hamilton Harbour Watershed Stewardship Project
Jim & Lori Hanes

Remedial Action Plan for Hamilton Harbour

4. Urbanization & Land Management

Emerging Issues:

- RAP targets in municipal planning documents
- Pressure to expand urban boundaries and transportation networks
- Implementation of watershed planning strategies

Remedial Action Plan for Hamilton Harbour

5. Public Access and Aesthetics

The Problem:

- Access restricted

- South shore industrial and fenced

NO TRESPASSING

Remedial Action Plan for Hamilton Harbour

5. Public Access and Aesthetics

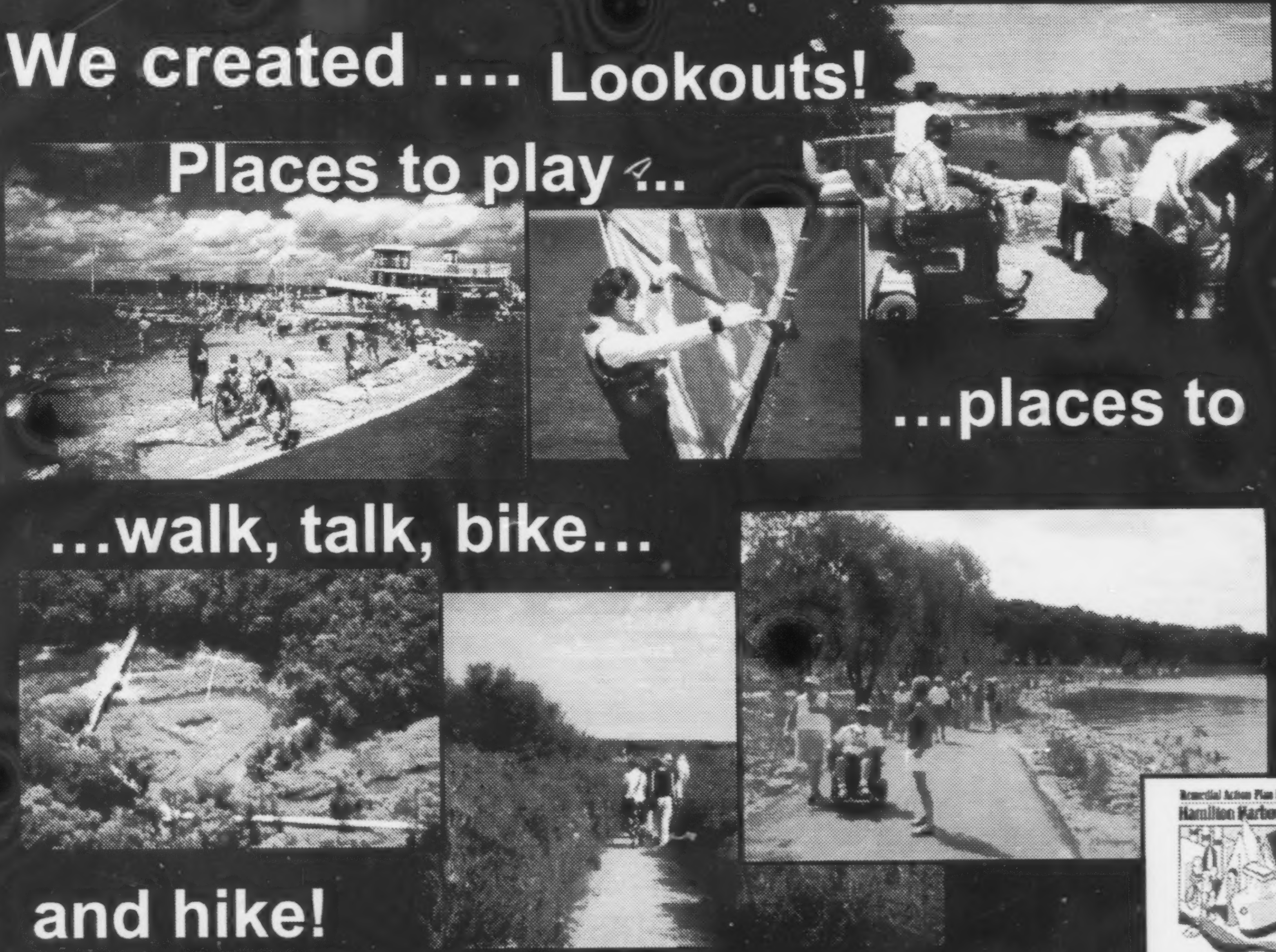
Goal:

25% of the shoreline accessible to the public

Progress:

21% of shoreline now accessible to the public

Remedial Action Plan for Hamilton Harbour



We created …. Lookouts!

Places to play ...

...places to

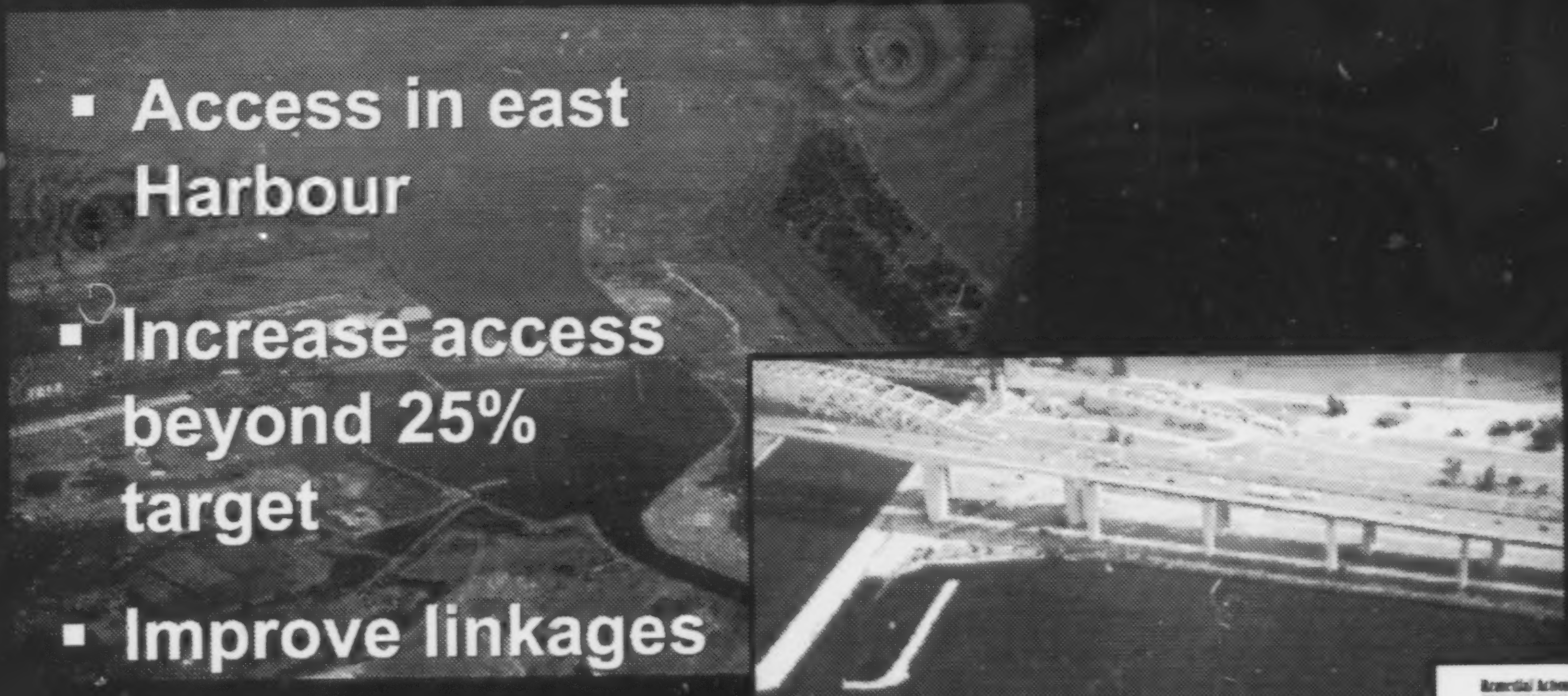
...walk, talk, bike...

and hike!

Remedial Action Plan for
Hamilton Harbour

5. Public Access and Aesthetics

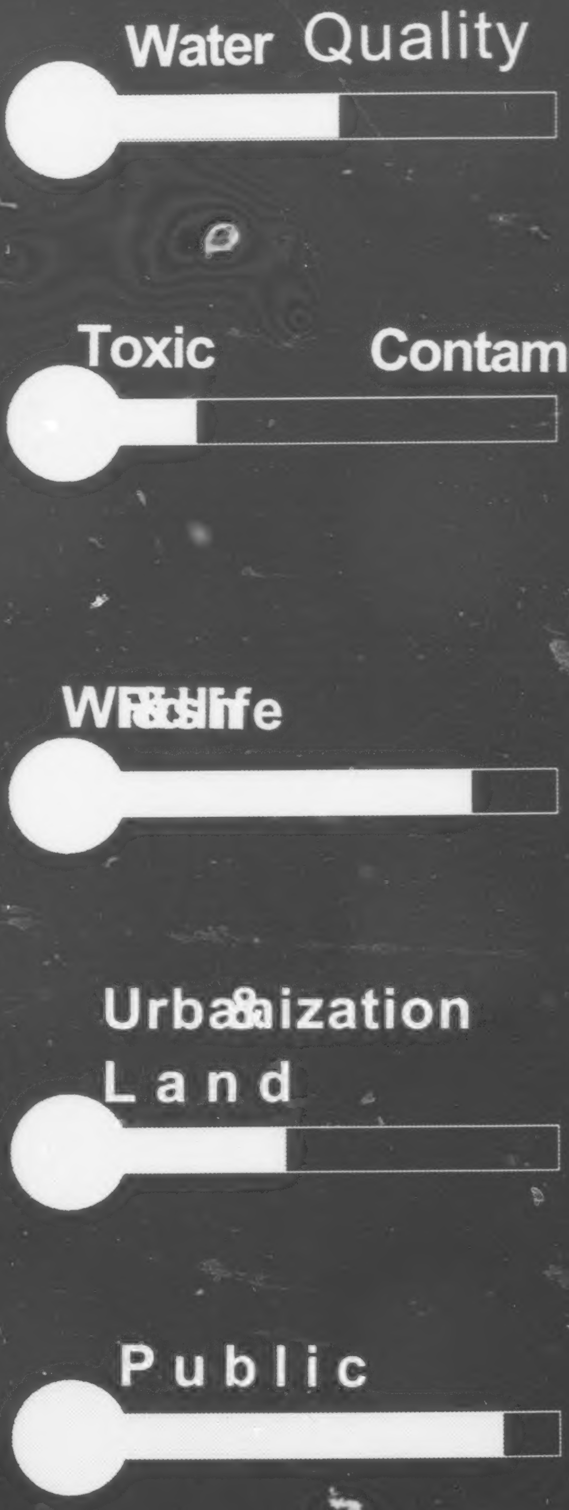
Emerging Issues:



- Access in east Harbour
- Increase access beyond 25% target
- Improve linkages

Remedial Action Plan for
Hamilton Harbour

PROGRESS...



Water Quality

Toxic Contaminati

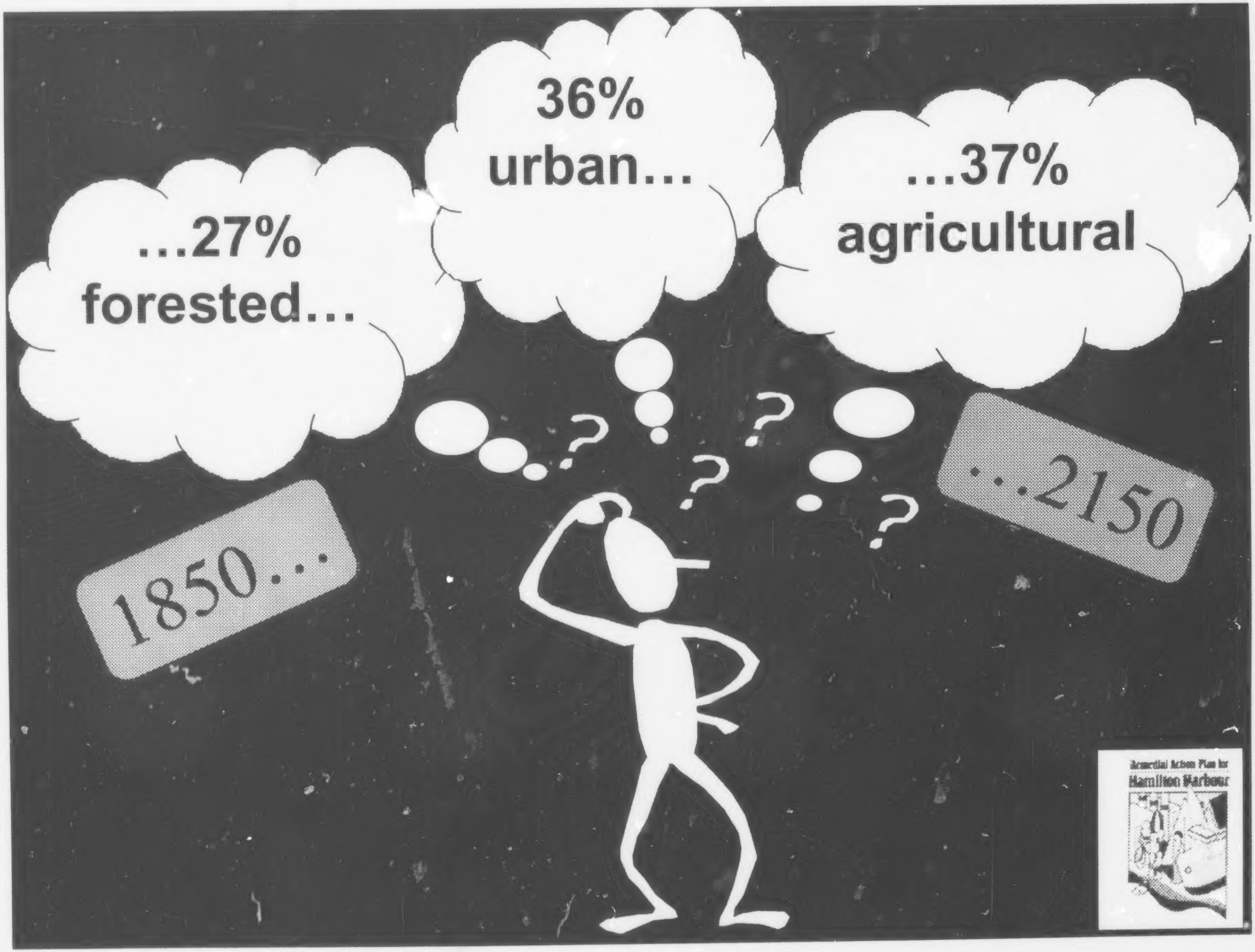
Fish Wildlife

Urbanization &

Land

Public

Remedial Action Plan for
Hamilton Harbour



1850...

...27% forested...

36% urban...

...37% agricultural

...2150

Remedial Action Plan for
Hamilton Harbour

Is Hamilton Harbour a "*local indicator*" for the future of Lake Ontario?

Remedial Action Plan for
Hamilton Harbour

PARTNERSHIPS IN ACTION FOR SUCCESS

FISH & WILDLIFE HABITAT RESTORATION PROJECT

Environment Canada
Environnement Canada

Remedial Action Plan for Hamilton Harbour

THE REGIONAL MUNICIPALITY OF HAMILTON-WENTWORTH

HALTON REGION CONSERVATION AUTHORITY

Halton
A World Class Place to Be

Canada

GREAT LAKES 2000 CLEANUP FUND

FONDS D'ASSAINISSEMENT DES GRANDS LACS 2000

FRIENDS of the ENVIRONMENT Foundation

CITY OF BURLINGTON

McMASTER UNIVERSITY

The Hamilton Harbour Commissioners

Royal Botanical Gardens
Les jardins botaniques royaux

Paradise

BAY AREA RESTORATION COUNCIL
OF HAMILTON-WENTWORTH AND HALTON REGIONS INC

HAMILTON NATURALISTS' CLUB

Hamilton Region Conservation Authority

City of HAMILTON

jobsOntario
boulotOntario

Waterfront Regeneration Trust
Fiducie de régénération du secteur riverain

Fisheries and Oceans
Pêches et Océans

Ontario
Ministry of Environment and Energy
Ministère de l'Environnement et de l'Énergie

Ontario
Ministry of Natural Resources
Ministère des Richesses naturelles

Amphibian and Bird Indicators for Great Lakes Wetlands: the Marsh Monitoring Program

Russ Weeber & Mary Vallianatos
Bird Studies Canada

Great Lakes Wetlands

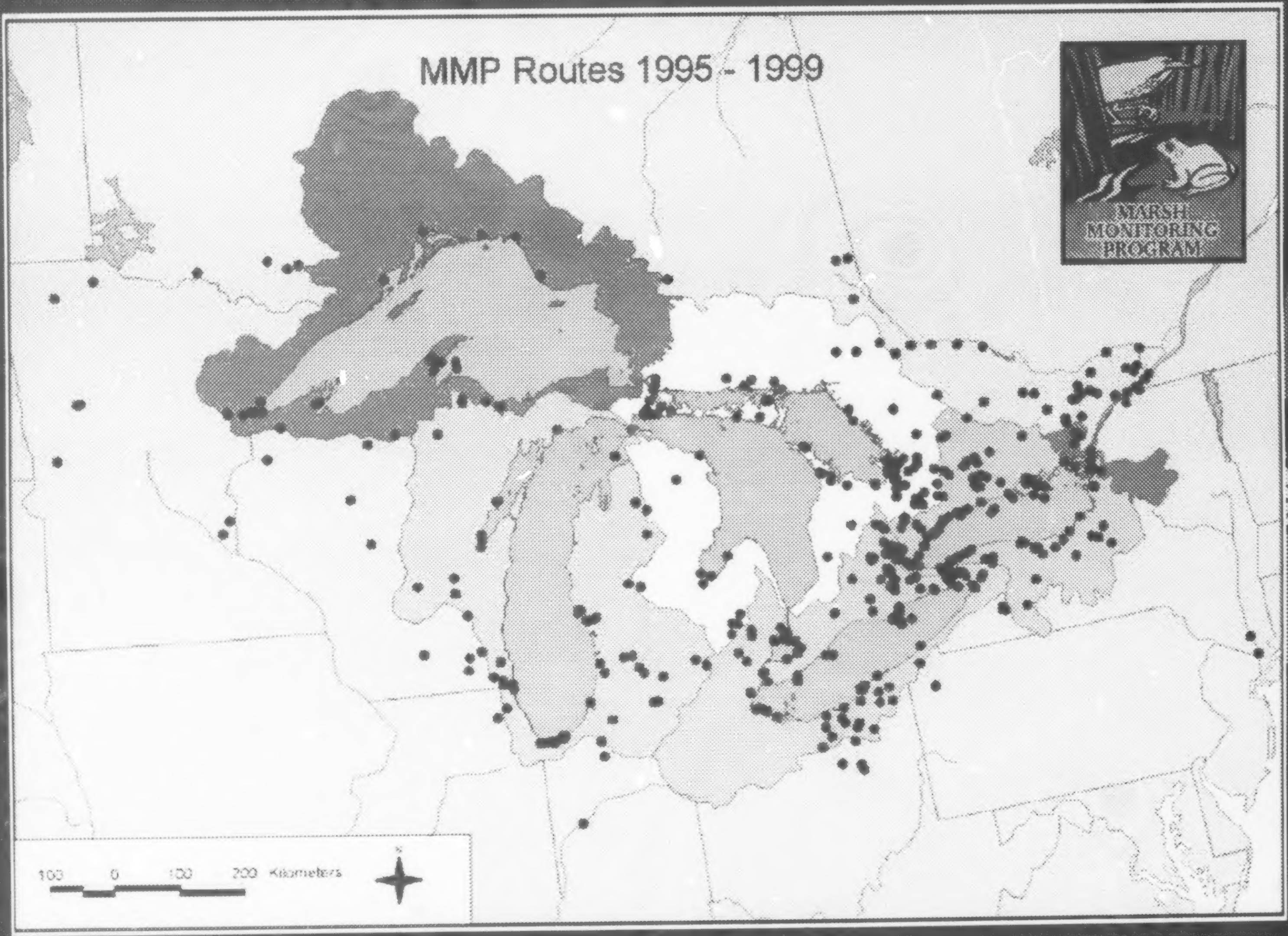
Conservation & Restoration

[illegible]

Vision

Great Lakes marshes of sufficient quality and quantity to support diverse breeding populations of amphibians and birds.

MMP Routes 1995 - 1999


MARSH MONITORING PROGRAM
100
0
100
200
Kilometers
N

Partnerships

Bird Studies Canada
Études d'Oiseaux Canada

Environment Canada
Ontario Region

Environnement Canada
Région de l'Ontario

United States Environmental Protection Agency

Great Lakes United

Great Lakes Protection Fund

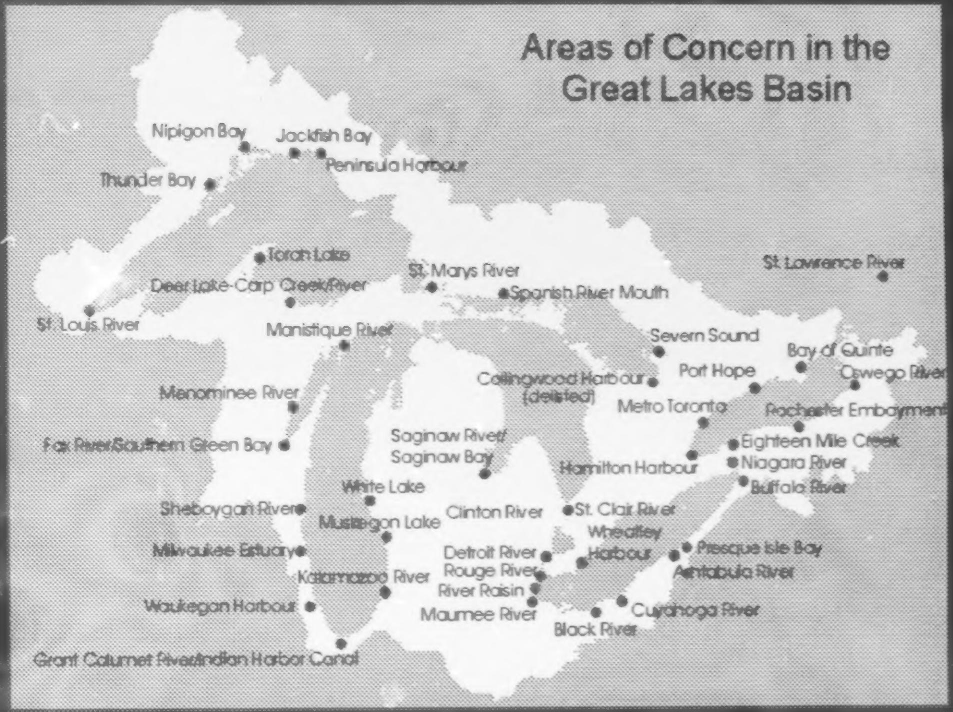
Objectives

1) Monitor breeding amphibians and birds

2) Assess habitat relationships

Virginia Rail

3) Help assess management & restoration


Areas of Concern in the Great Lakes Basin

Nipigon Bay
Jackfish Bay
Peninsula Harbour
Thunder Bay
Torch Lake
Deer Lake-Carp Creek/River
St. Marys River
Spanish River Mouth
St. Lawrence River
St. Louis River
Manistique River
Severn Sound
Bay of Quinte
Collingwood Harbour (delisted)
Port Hope
Oswego River
Menominee River
Metro Toronto
Rochester Embayment
Fox River/Southern Green Bay
Saginaw River/ Saginaw Bay
Eighteen Mile Creek
Niagara River
Hamilton Harbour
Buffalo River
White Lake
Sheboygan River
Clinton River
St. Clair River
Muskegon Lake
Wheatley Harbour
Detroit River
Presque Isle Bay
Milwaukee Estuary
Rouge River
Ashtabula River
Kalamazoo River
River Raisin
Waukegan Harbour
Maumee River
Cuyahoga River
Black River
Grand Calumet River/Indian Harbor Canal

4) Engage and motivate stakeholders

Amphibian Indicator

Spring Peeper

- Wetland-dependent
- Sensitive eggs & skin
- Sedentary
- Wide distribution
- Public interest

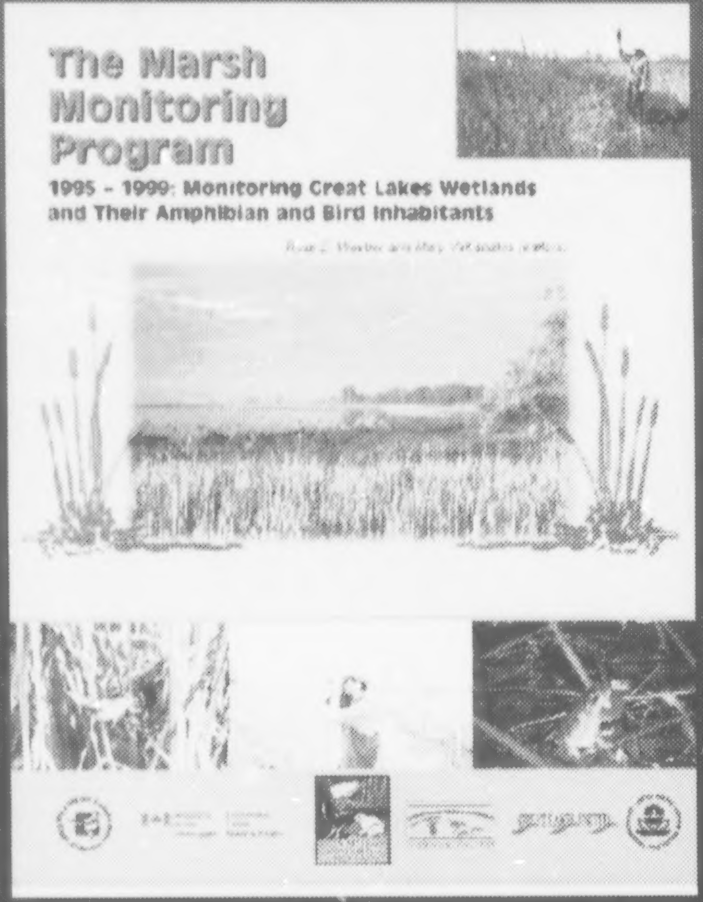
Bird Indicator

Pied-billed Grebe

- Wetland-dependent
- Wide distribution
- Easy to count
- Public interest

Reporting

- Basin-wide
- Lake level
- Biodiversity Investment Areas
- Areas of Concern
- Wildlife Management Areas
- Program participants



The Marsh Monitoring Program

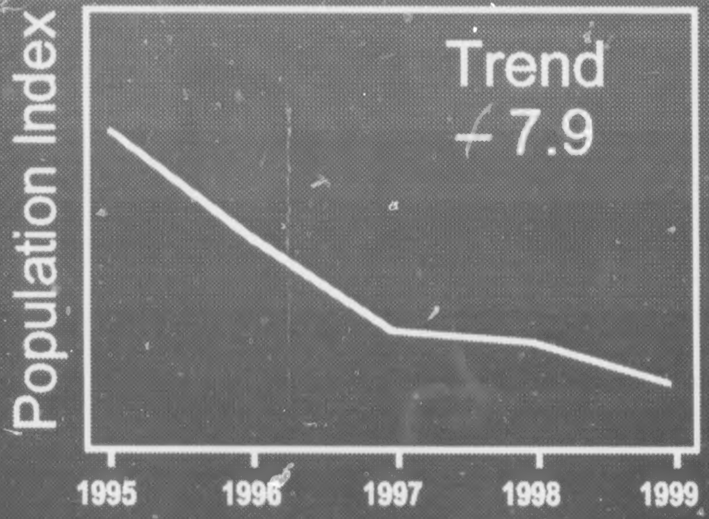
1995 – 1999: Monitoring Great Lakes Wetlands and Their Amphibian and Bird Inhabitants

MMP Routes

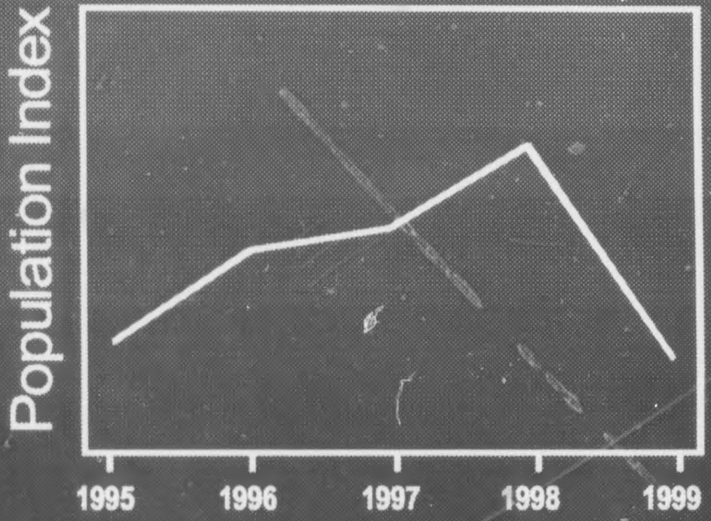
- Permanent wetlands
- Large wetlands
- Cattail and grasses/sedges
- Route coverage
  - strongest in Erie and Ontario
  - weakest in Superior

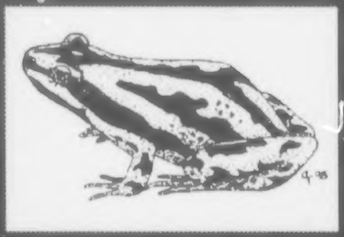
Is the presence of each species changing through time?

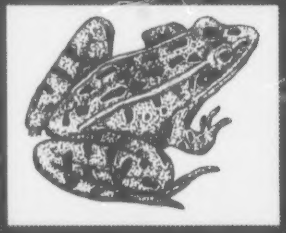
Chorus Frog



Northern Leopard Frog

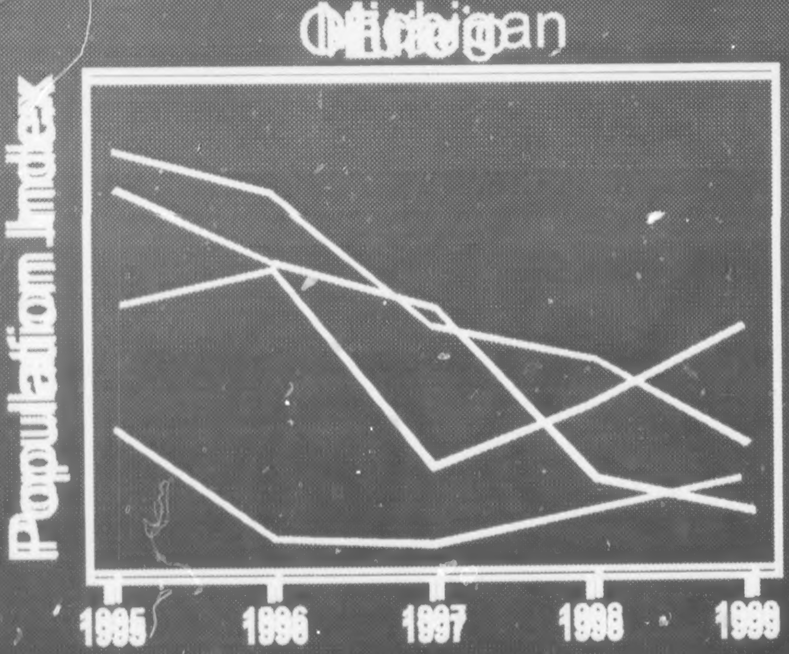


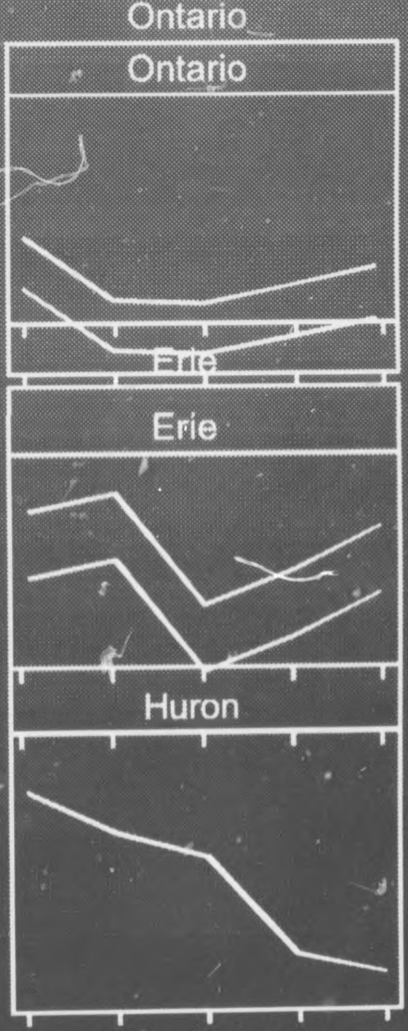




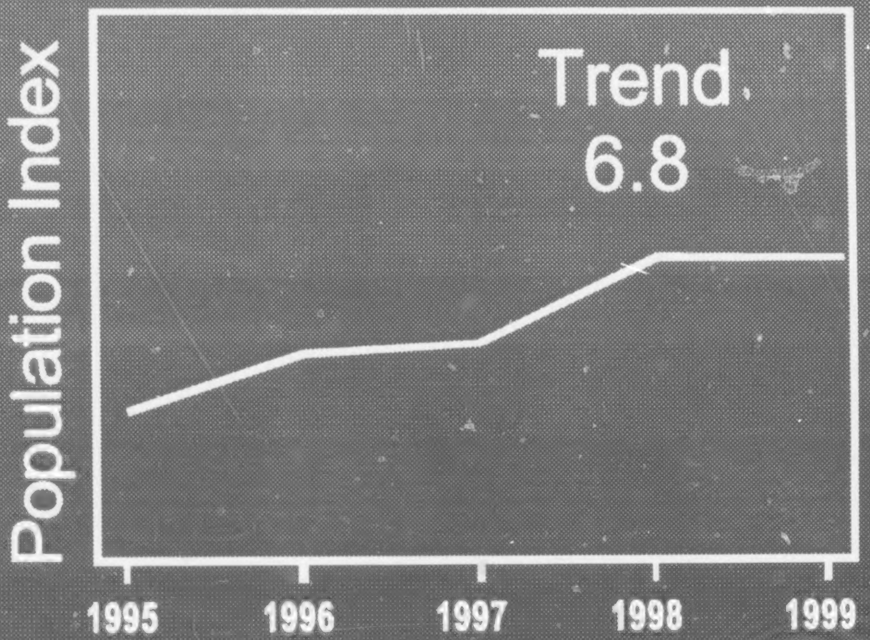
Do trends vary among lake basins?

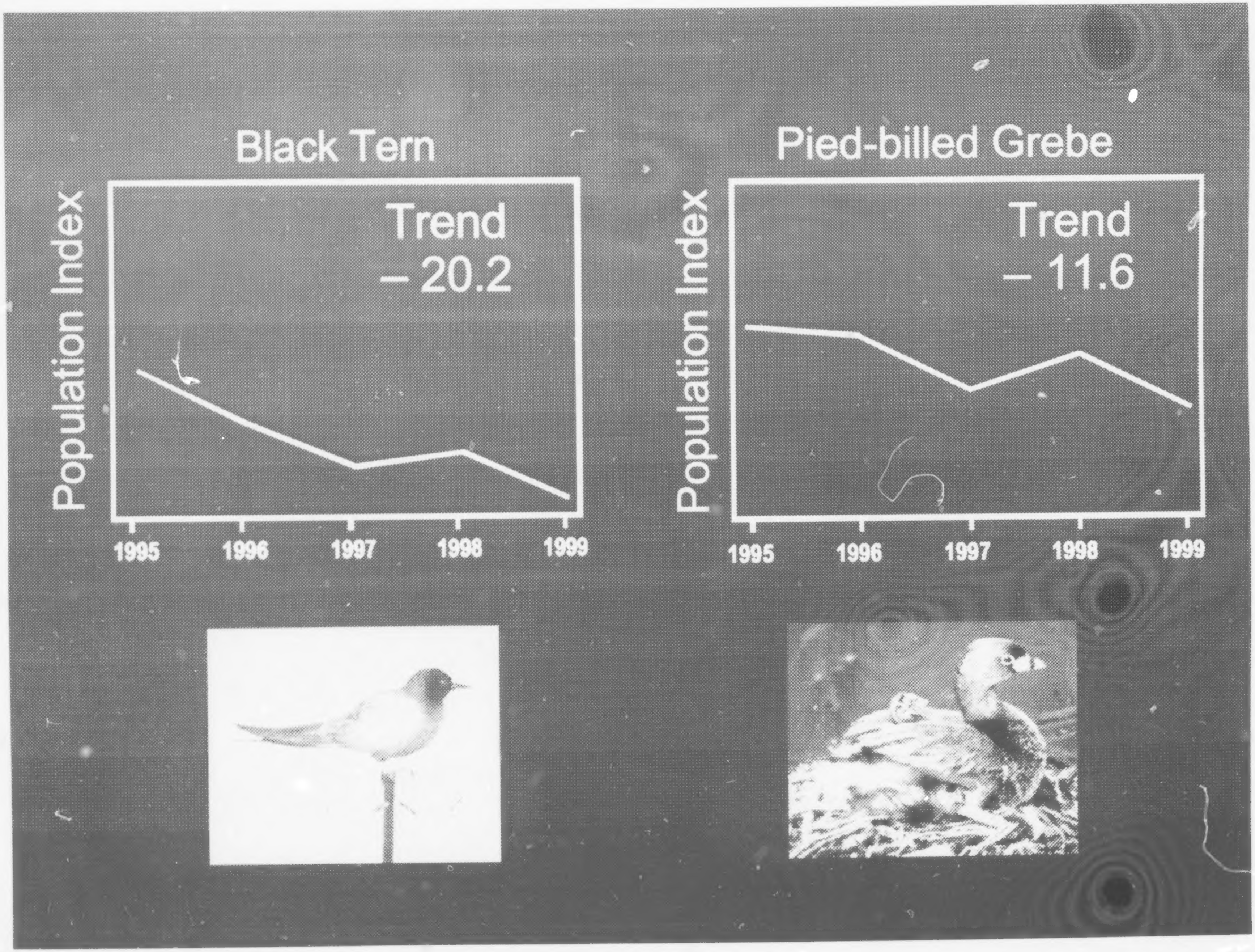
Chorus Frog





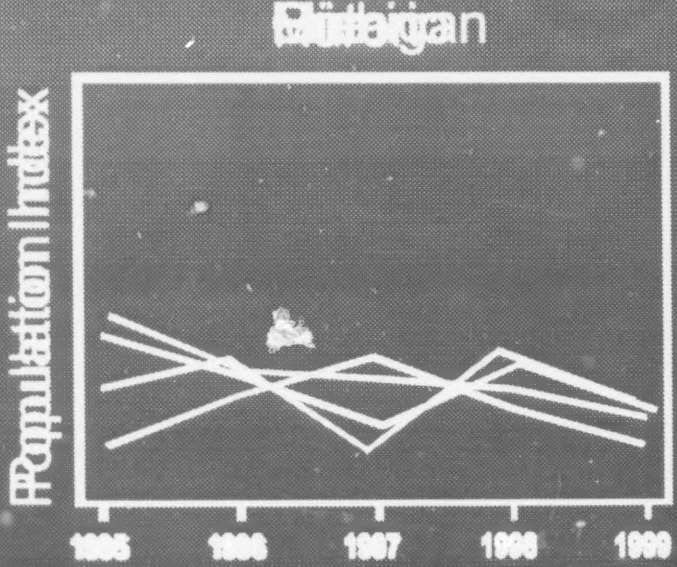
Are the numbers of individuals changing through time?

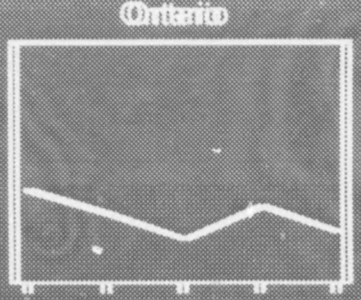

Common Yellowthroat

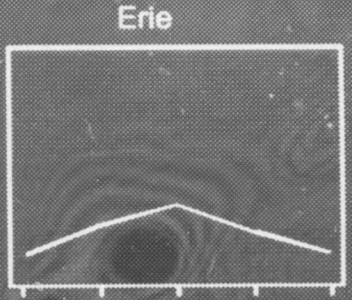

Black Tern
Trend
– 20.2
Population Index
1995
1996
1997
1998
1999
Pied-billed Grebe
Trend
– 11.6
Population Index
1995
1996
1997
1998
1999

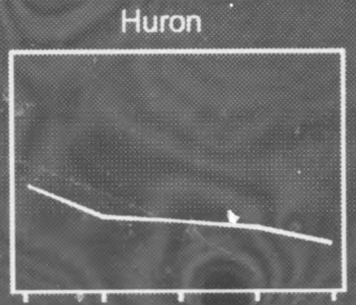
Do trends vary among lake basins?

Pied-billed
Grebe









Habitat Relationships

What habitats are at risk?

How do we best manage wetlands?

Enhancement

- Endpoints for Success
- Indices >> Populations
- Participant Recruitment & Retention
- Data Sharing & Reporting

Marsh Monitoring Program
Bird Studies Canada
www.bsc-eoc.org

International Alvar Conservation Initiative

Heather Potter - The Nature Conservancy

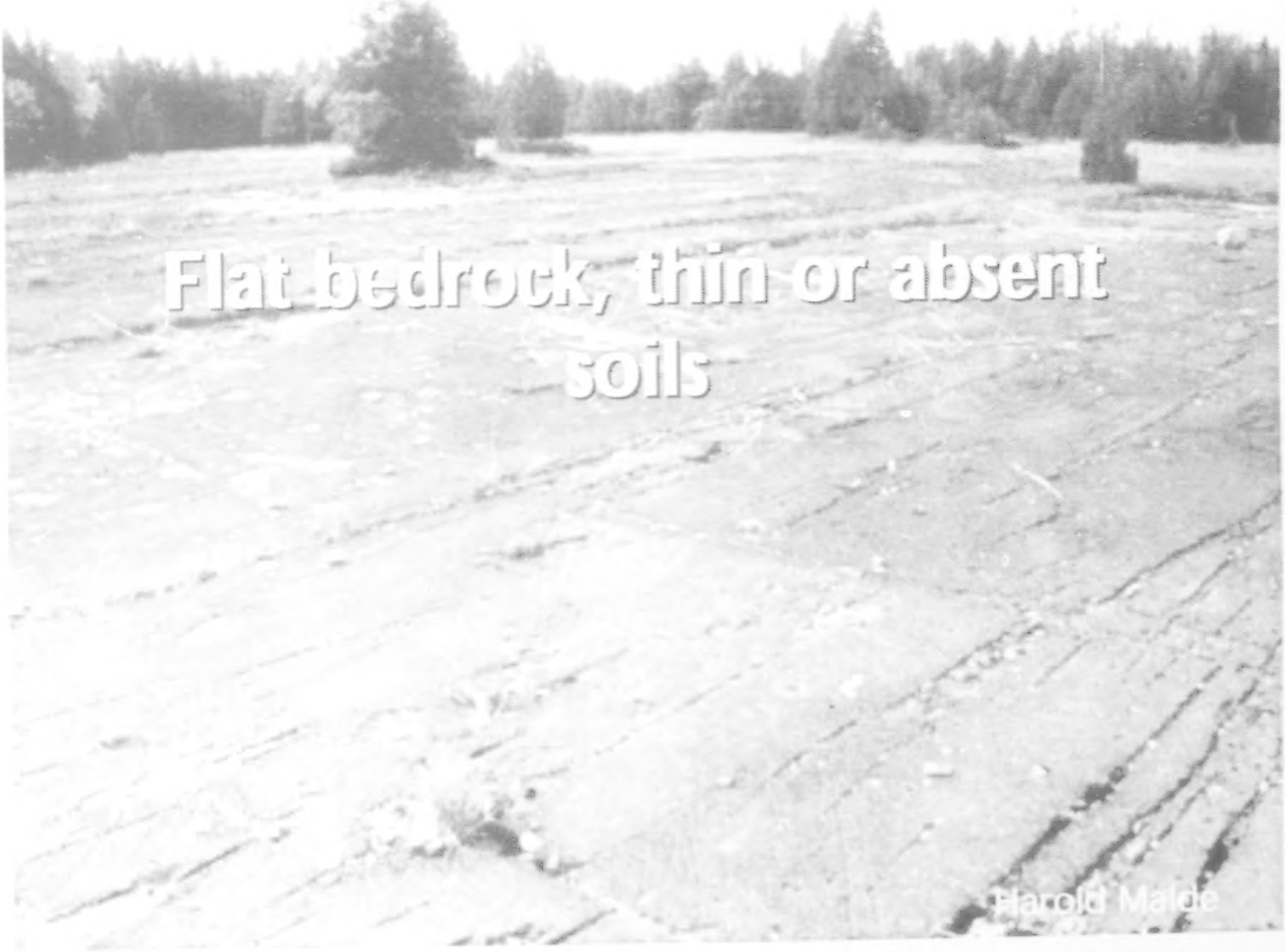
Ron Reid - Couchiching Conservancy

Objectives of Presentation

- What are alvars?
- What are the conservation challenges?
- How did the *International Alvar Conservation Initiative* address these challenges?
- What have we learned?

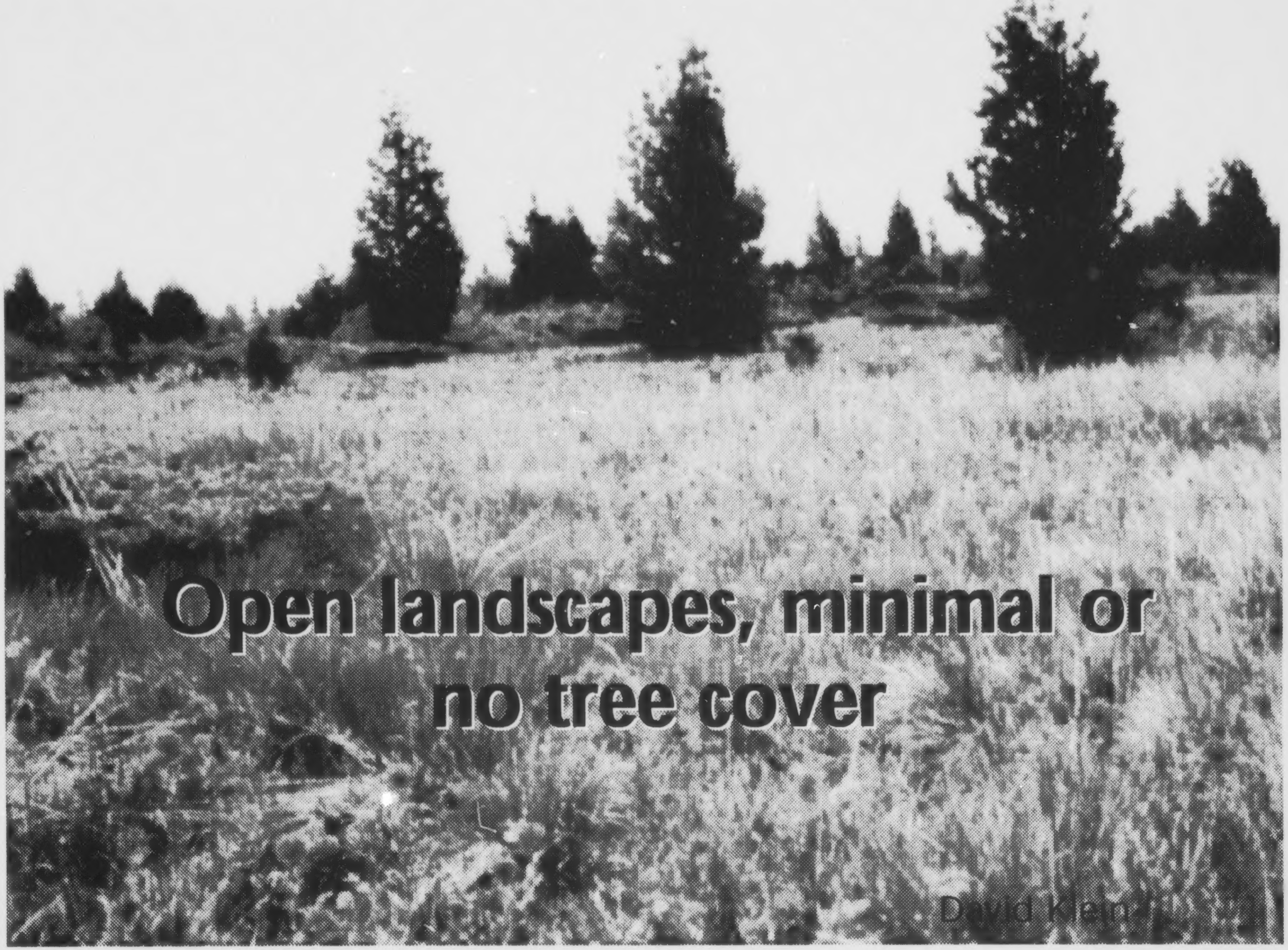
Alvar

- The Swedish word "alvar" means…
- The layer of soil just beneath the top layer



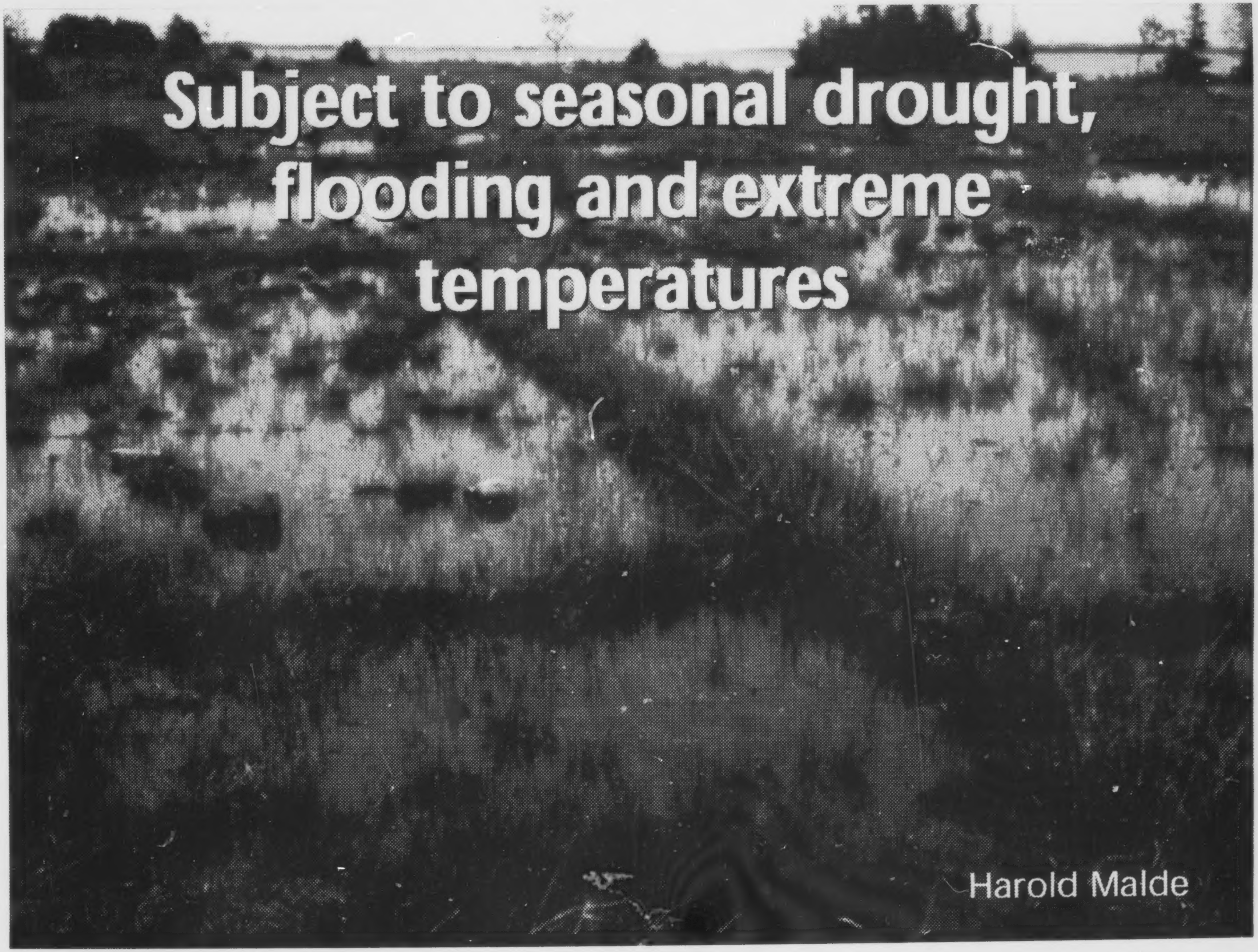
Flat bedrock, thin or absent soils

Harold Malde



Open landscapes, minimal or no tree cover

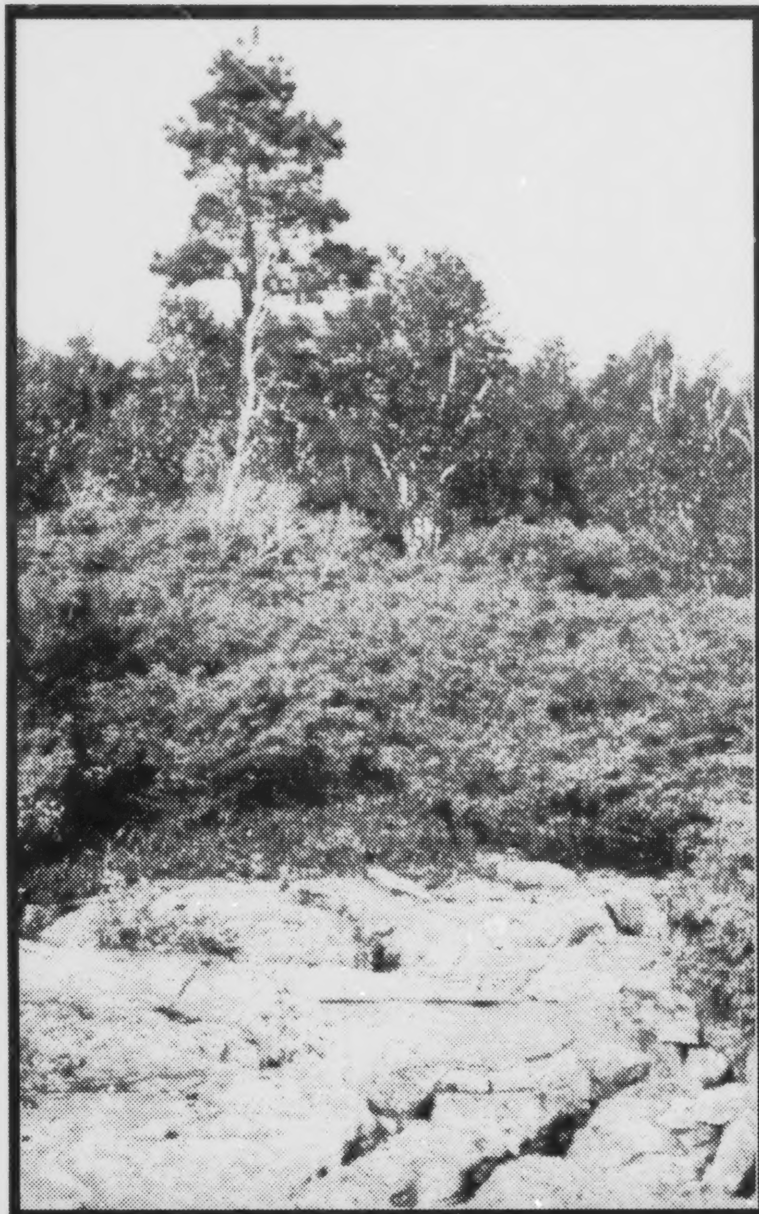
David Klein



Subject to seasonal drought,
flooding and extreme
temperatures

Harold Malde

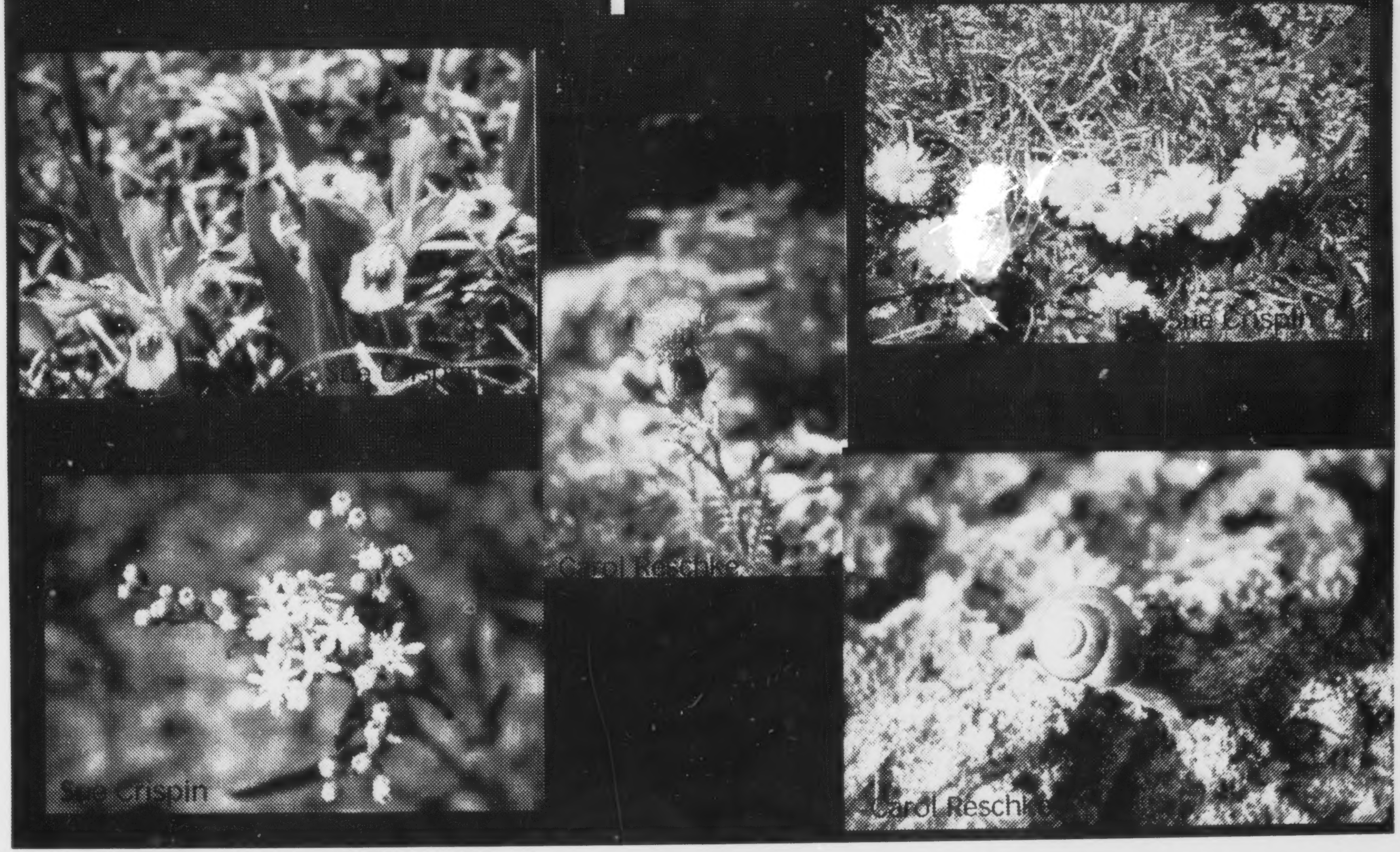
Distinctive plant species, characteristic vegetation associations



Carol Reschke

Sue Crispin

Contain rare and/or endemic species



Sue Crispin

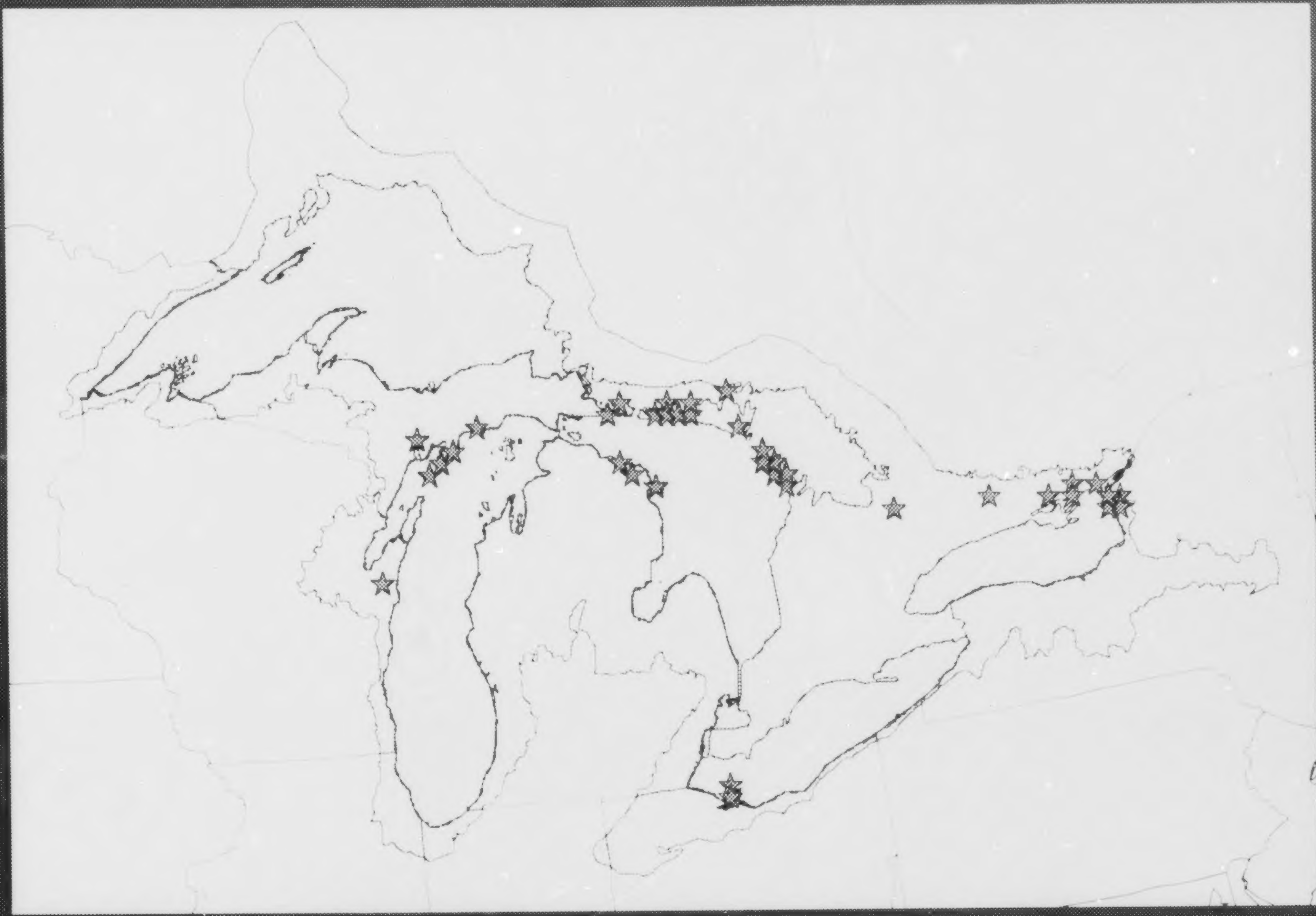
Carol Reschke

Sue Crispin

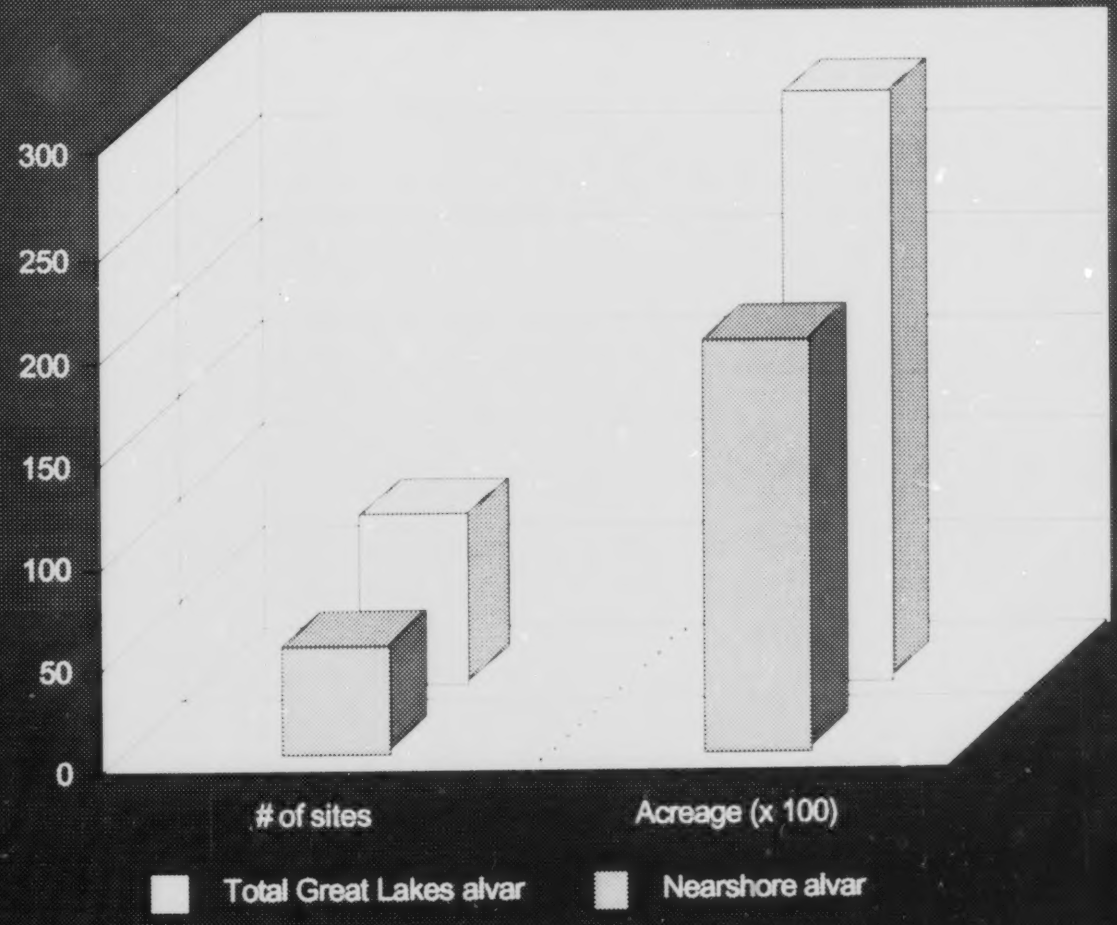
Sue Crispin

Carol Reschke

Great Lakes Alvars

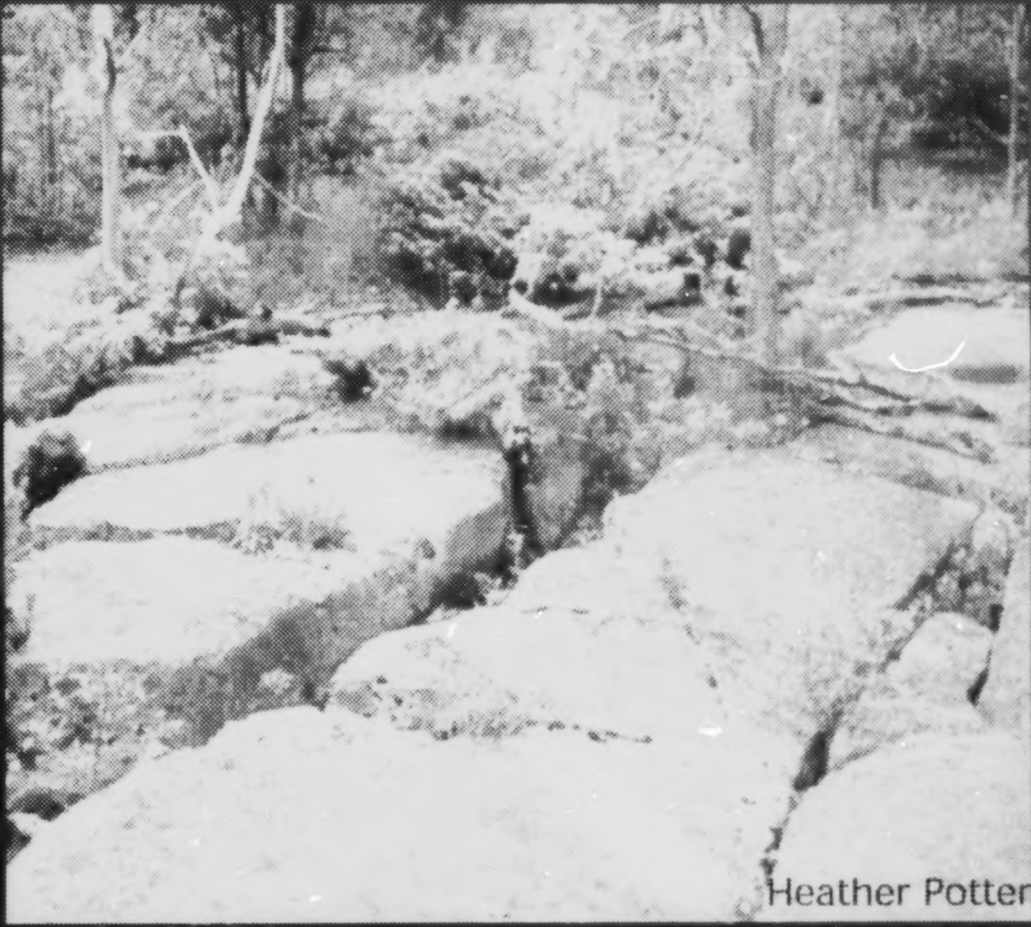


Nearshore and Total Alvars



The Conservation Challenge

- Alvars are unique to the Great Lakes and globally rare



Heather Potter

The Conservation Challenge

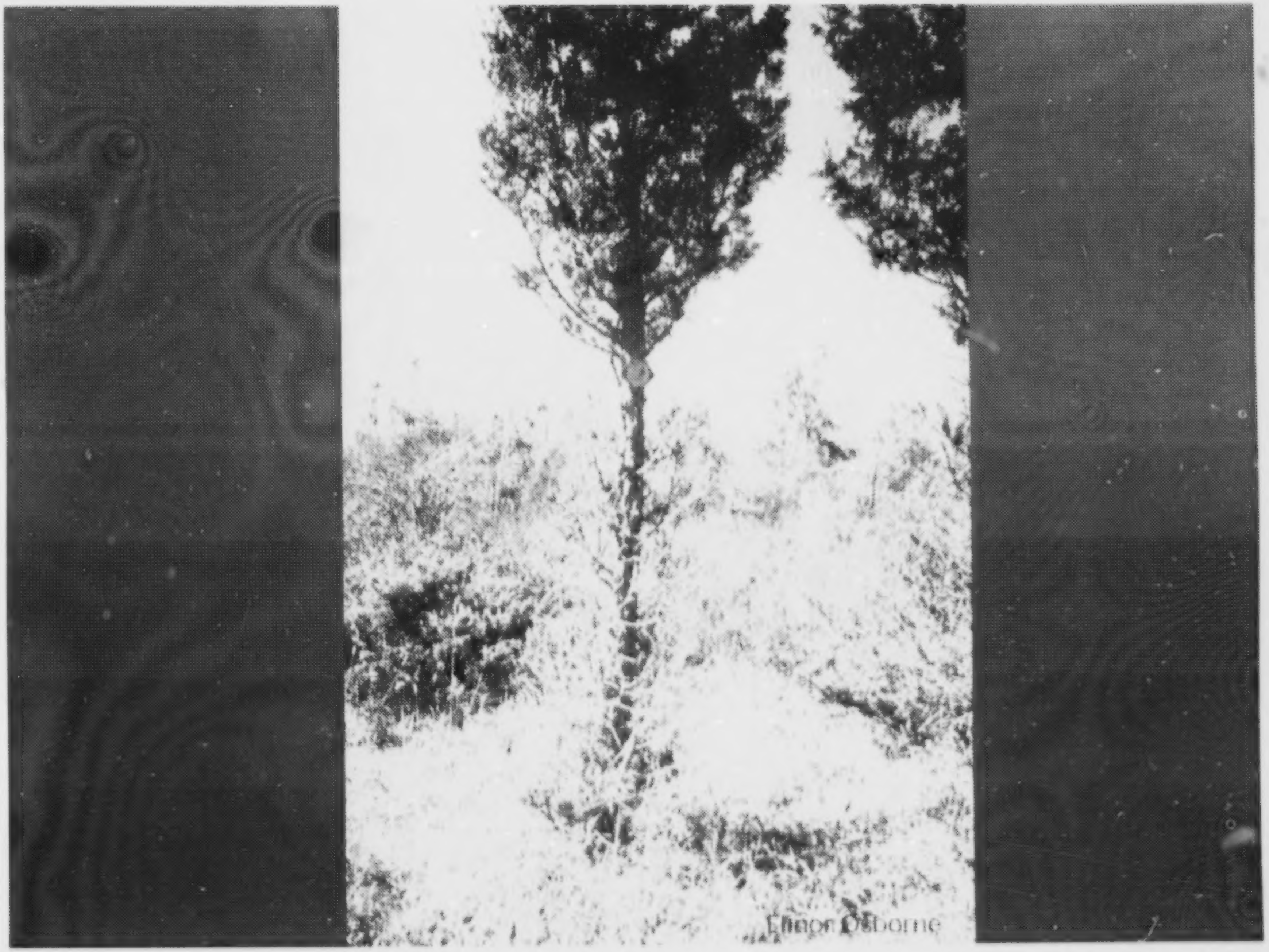
- Alvars are unique to the Great Lakes and globally rare
- Threatened by incompatible land uses

Heather Potter

Heather Potter

Harold Malde

Sandy Bonnaho



Elinor Osborne

The Conservation Challenge

- Alvars are unique to the Great Lakes and globally rare
- Threatened by incompatible land uses
- Conservation efforts have been scattered, isolated and uncoordinated

Harold Malde

The Conservation Challenge

- Alvars are unique to the Great Lakes and globally rare
- Threatened by incompatible land uses
- Conservation efforts have been scattered, isolated and uncoordinated
- Lack of awareness about alvar habitats

Heather Potter

International Alvar Conservation Initiative (1994)

International Alvar Conservation Initiative

A collaborative effort aimed at providing a unified, consistent approach to understanding and conserving the Great Lakes' rare and vulnerable alvar ecosystems

Andy Zepp

Major Accomplishments

1. Assessment of alvar distribution & conservation status
2. Documentation of priority sites
3. Knowledge of how alvar systems function
4. Strategies for alvar protection/stewardship
5. Awareness of uniqueness & value of alvars

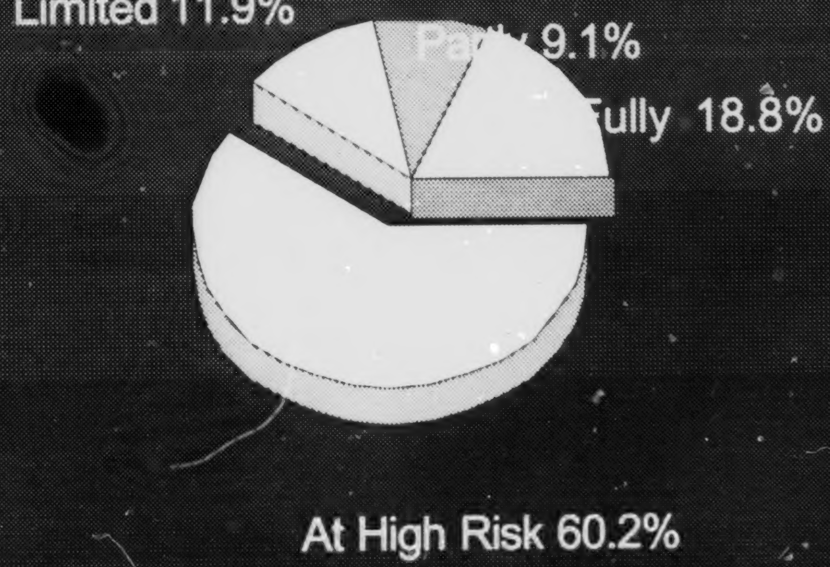
Major Accomplishments

1. Assessment of alvar distribution & conservation status
2. Documentation of priority sites
3. Knowledge of how alvar systems function
4. Strategies for alvar protection/stewardship
5. Awareness of uniqueness & value of alvars
6. Model for binational collaboration in the conservation of biodiversity

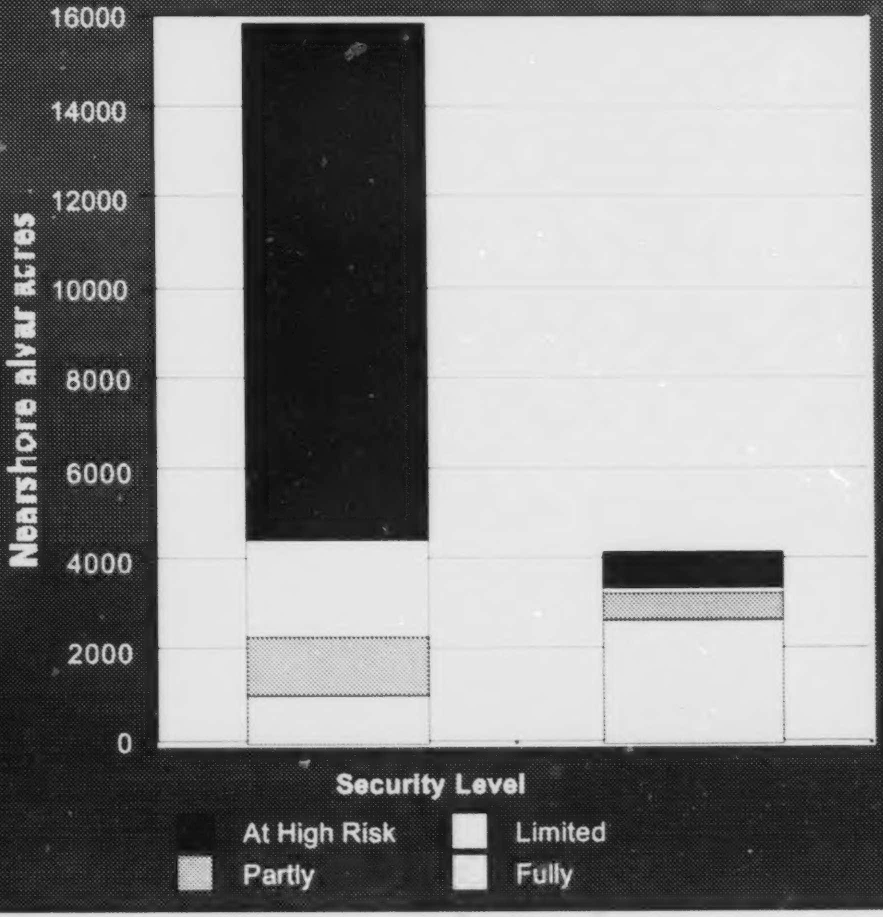
What Have We Learned?

Degree of Protection

Nearshore Alvar Acreage

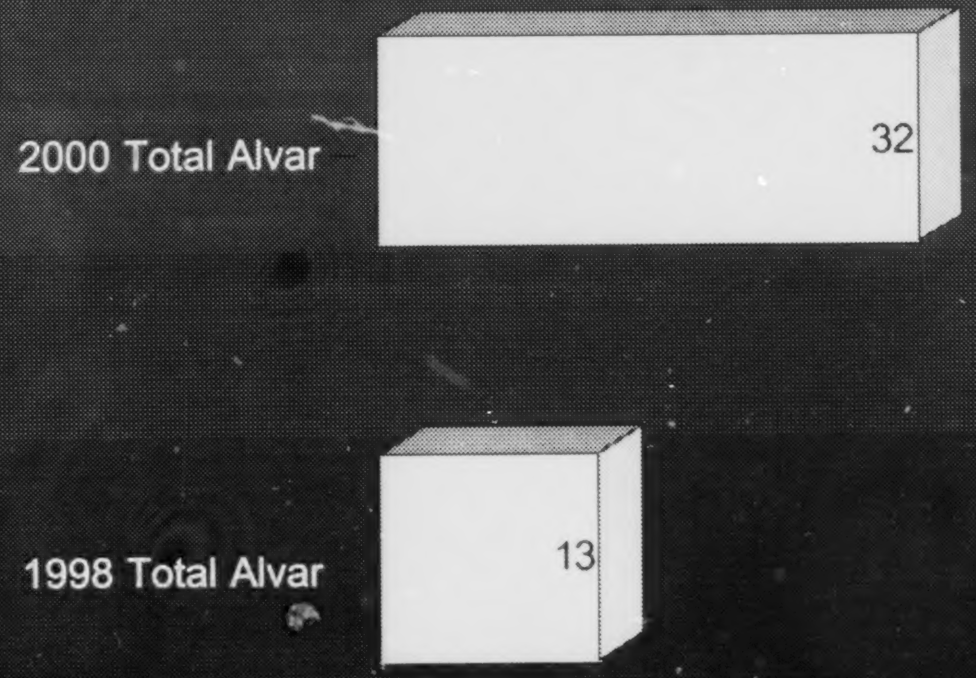


Level of Protection for Nearshore Alvars

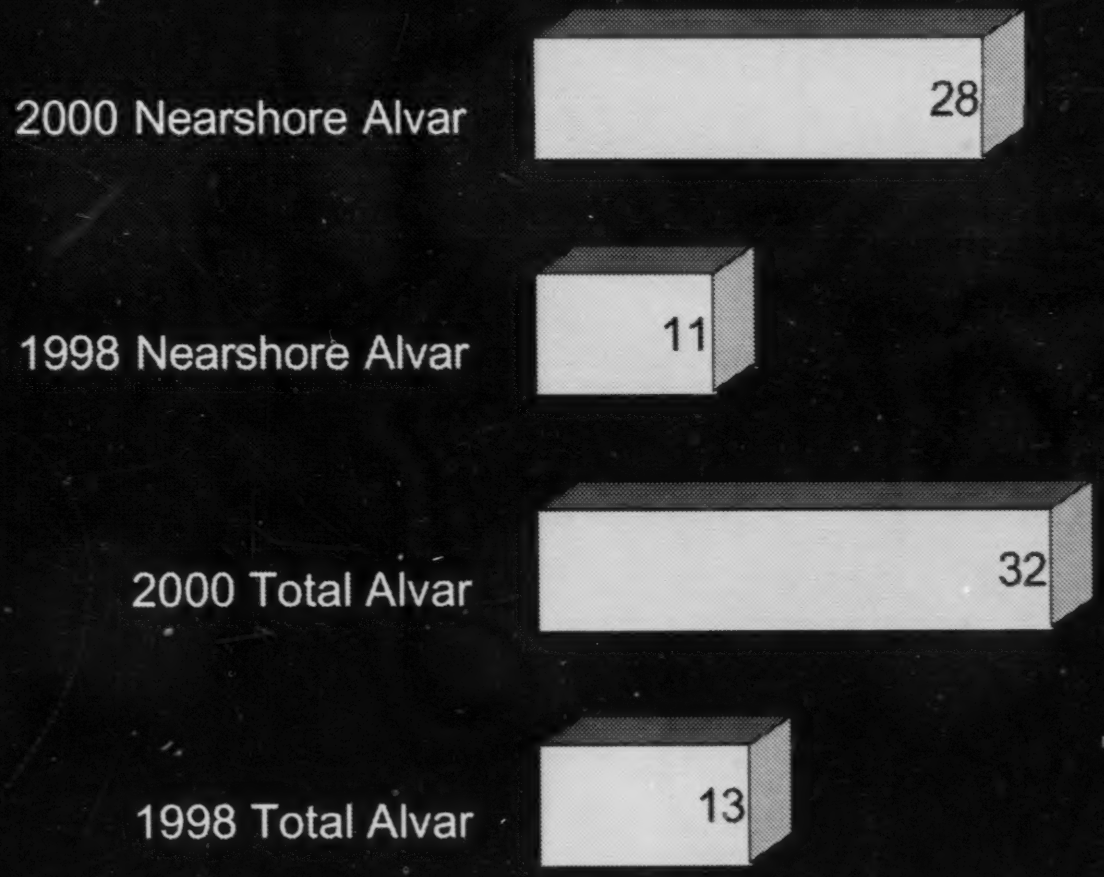


Alvar Protected: 1998-2000

Percentage fully or partly protected



Alvar Protected: 1998-2000



Putting Indicators to Use
Summary & Charge

Nancy Stadler-Salt
Environment Canada

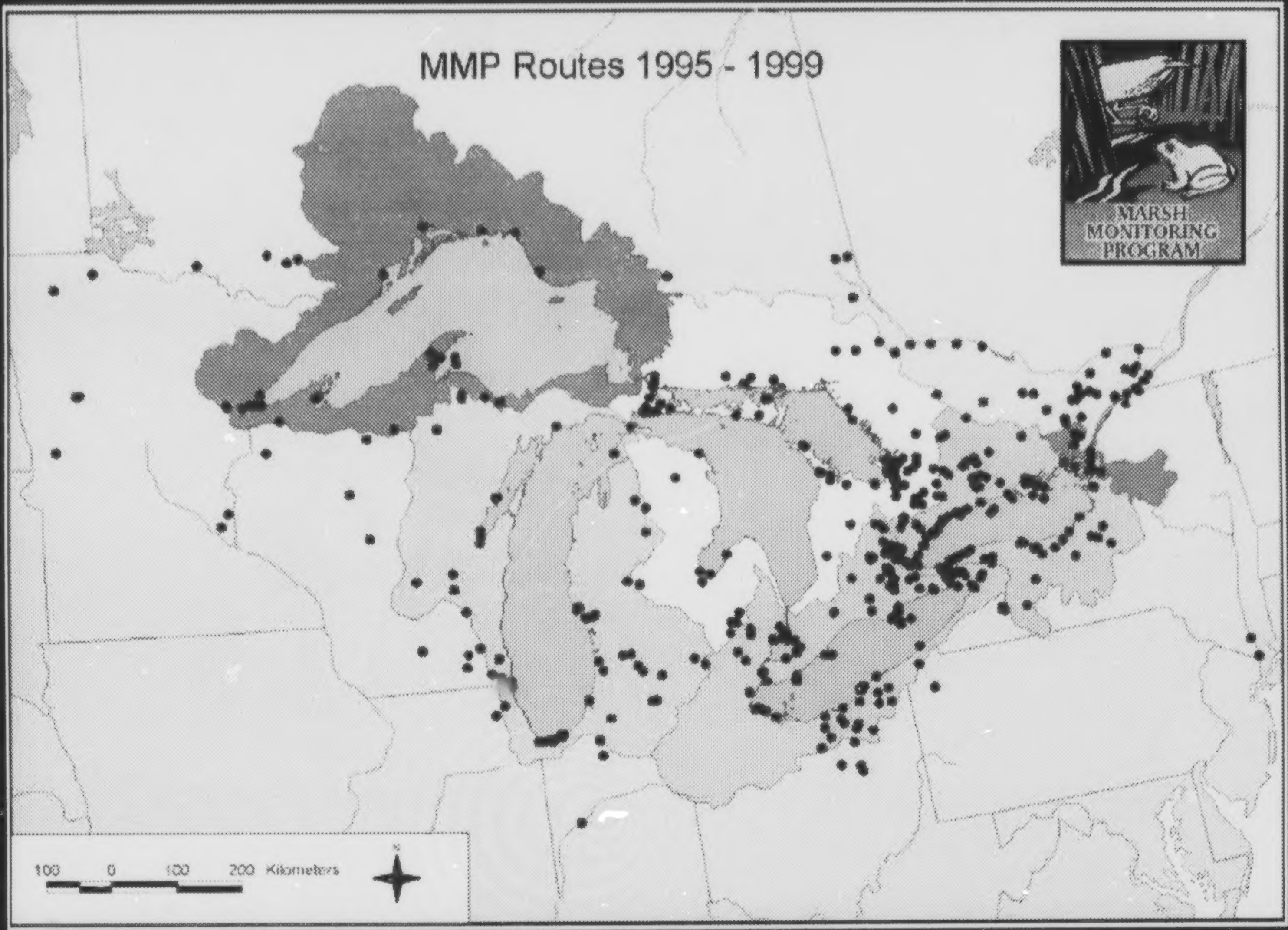
Success Stories Themes

- Improvement to the Great Lakes or local ecosystem
- Forged linkages between environment, community and economy
- "Win-win" situations have been created
- Strong partnerships have been formed.
- Sustainability
- Broad stakeholder involvement
- Demonstrate that efforts are effective

Basinwide Pressures

- Habitat loss
- Invasive and non-native species
- Land use/development
- Increasing population

MMP Routes 1995 - 1999


MARSH
MONITORING
PROGRAM
100
0
100
200
Kilometers
N

Common Themes

- Volunteers have an important role
- Partnerships are important
- Outreach programs are necessary
- Strategic thinking

Breakout Sessions

- Hamilton Harbour AOC: Commitment the Key to Success
- Launching & Maintaining an Urban Ecosystem Initiative
- Leveraging Resources for Environmental Results
- Collection & Analysis of Monitoring Data
- Volunteer Recruitment & Retention

Breakout Sessions (con'd)

- Determining Priority Conservation Places
- Wild Rice Ecology and Management
- Shoreline Biodiversity Investment Areas
- Ecological Indices

Breakout Sessions

- Add some more tools to your toolbox!

Carbon Sequestration and Biodiversity Management Program

SOLEC 2000

Steve Hounsell

Ontario Power Generation

October 18, 2000

Driving Force Behind Program

- Biodiversity - restoration of forest in southern Ontario
- Management of greenhouse gases (CO_2)
- Multiple benefits of program were compelling.

Program Goals

- Plant 1.6 million native trees and shrubs over next 5 years in southern Ontario;

- Program directly linked to making tangible progress on greenhouse gas management and the conservation of biodiversity.

What Makes this Program Different?

- Targets regional scale forest habitat restoration, bulking up key forests and establishing habitat corridors.
- Responsive to habitat needs of wildlife that are vulnerable to woodland habitat loss and fragmentation.
- Directed towards enhancing vital ecological services on the landscape.

Project Criteria - a Framework for Success

- Must be in southern Ontario.
- Use appropriate native plant stock.
- Address regional scale habitat restoration priorities.
- Identify biodiversity objectives and measures.
- Assure protection of land base for forest maturation

Project Criteria - a Framework for Success

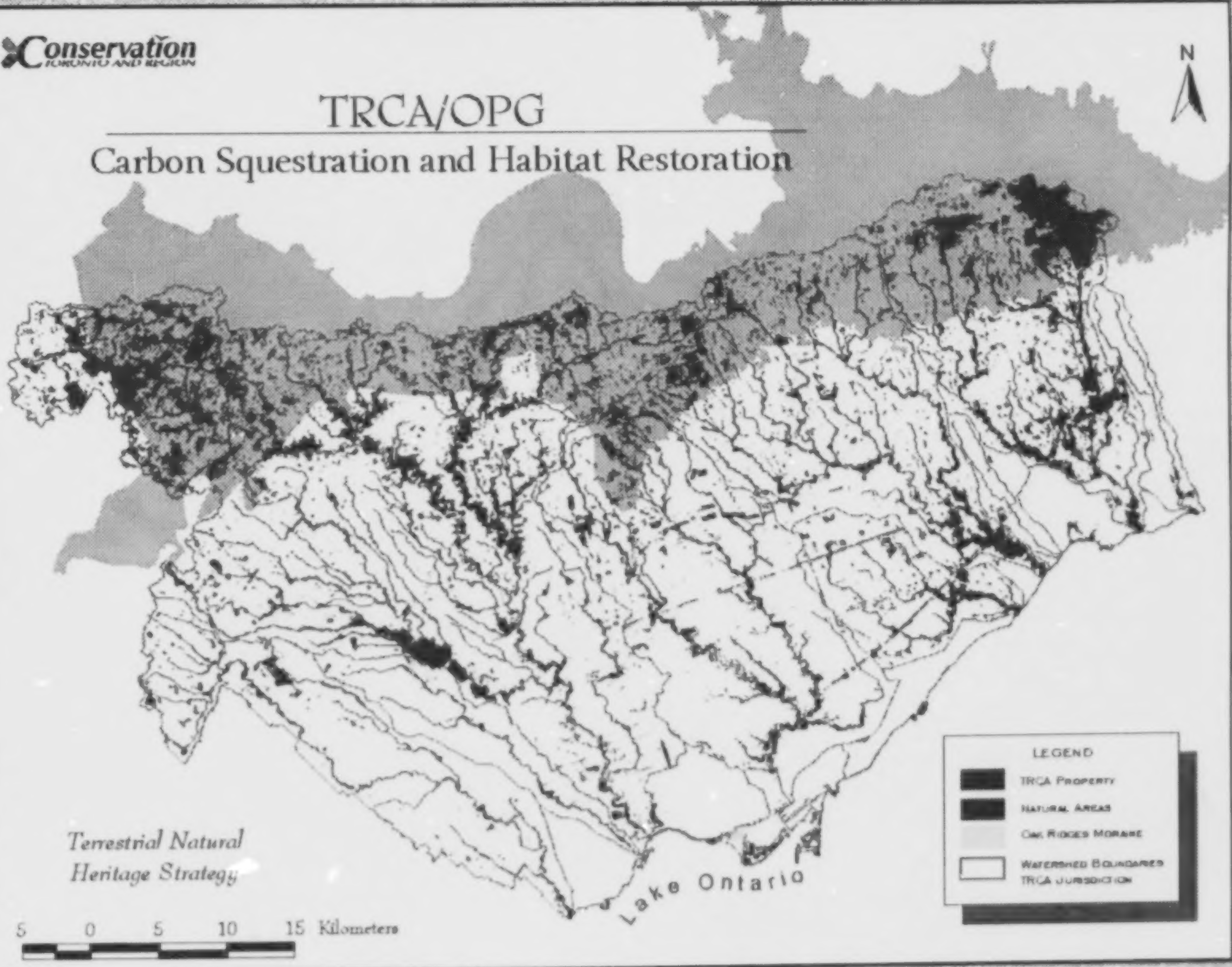
- Assure additionality of forest.
- Assure on-going management and monitoring within an adaptive management framework.
- Include opportunities for local stewardship involvement, ownership and education.
- Build lasting partnerships.

X

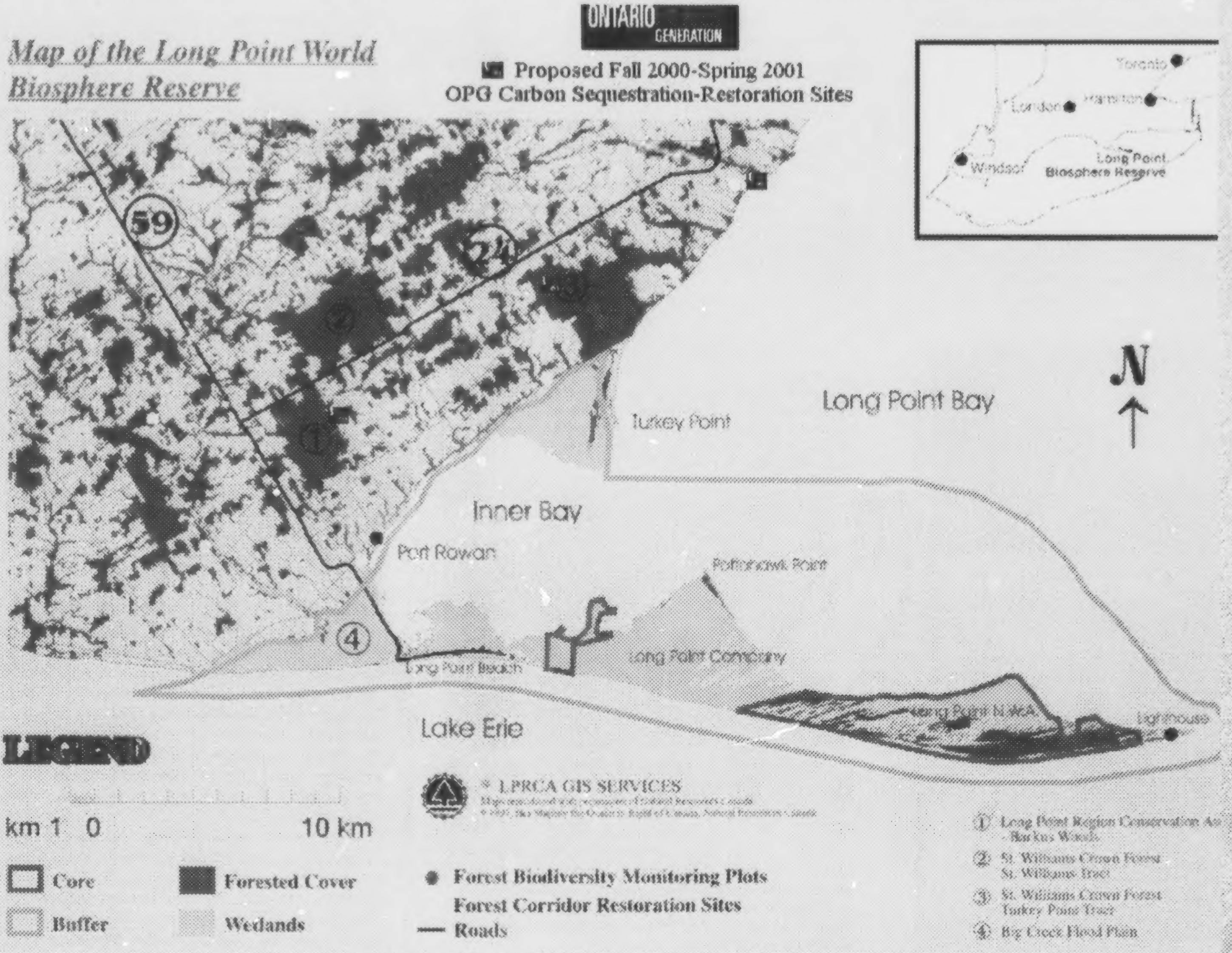
Conservation
TORONTO AND REGION

TRCA/OPG

Carbon Squestration and Habitat Restoration


N
Lake Ontario
Terrestrial Natural
Heritage Strategy
5 0 5 10 15 Kilometers
LEGEND
TRCA Property
Natural Areas
Oak Ridges Moraine
Watershed Boundaries
TRCA Jurisdiction

Map of the Long Point World Biosphere Reserve


ONTARIO GENERATION
Proposed Fall 2000-Spring 2001
OPG Carbon Sequestration-Restoration Sites
Toronto
London
Hamilton
Windsor
Long Point Biosphere Reserve
59
24
①
②
③
④
N
Long Point Bay
Turkey Point
Inner Bay
Port Rowan
Pottohawk Point
Long Point Company
Long Point Beach
Long Point N.W.A.
Lighthouse
Lake Erie
LEGEND
km 1 0 10 km
Core
Buffer
Forested Cover
Wedlands
● Forest Biodiversity Monitoring Plots
Forest Corridor Restoration Sites
— Roads
* LPRCA GIS SERVICES
① Long Point Region Conservation Au - Backus Woods
② St. Williams Crown Forest St. Williams Tract
③ St. Williams Crown Forest Turkey Point Tract
④ Big Creek Flood Plain

Future Work:

- 1.4 million trees and shrubs yet to be planted;
- Several new partnerships emerging, as well as building on existing ones;
- Genuine excitement about the possibilities and benefits.

Challenges:

- Availability of genetically appropriate native plant material to meet demand;

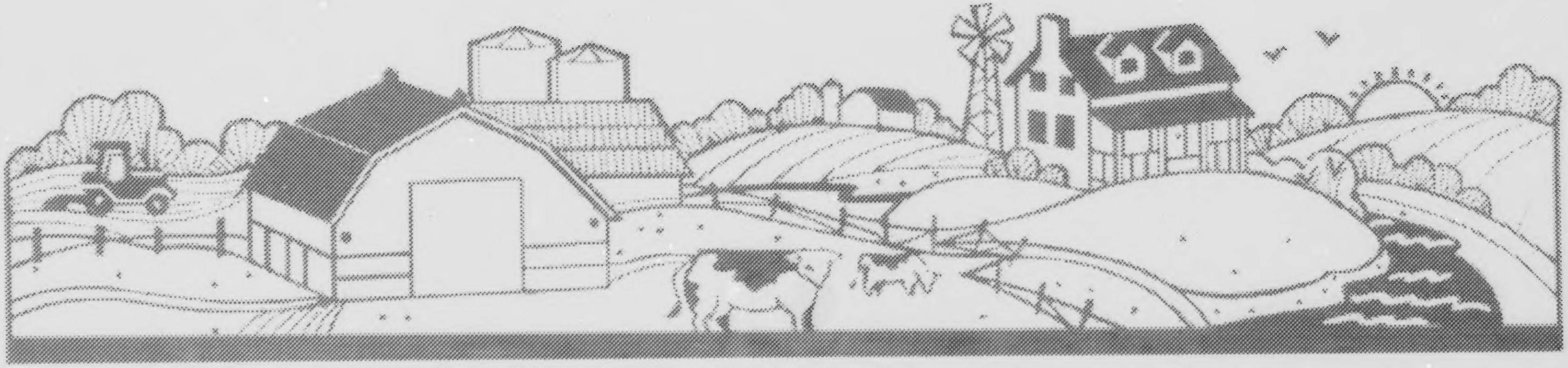
- Permanence - availability of lands in appropriate locations for long term restoration.

Opportunity

- Development of market incentives to attract industry into investing in large scale habitat restoration projects that will also address their business need to offset carbon emissions.

Summary

- Exemplifies how industry can act as a catalyst for the enhancement of long-term ecosystem health.



WATER

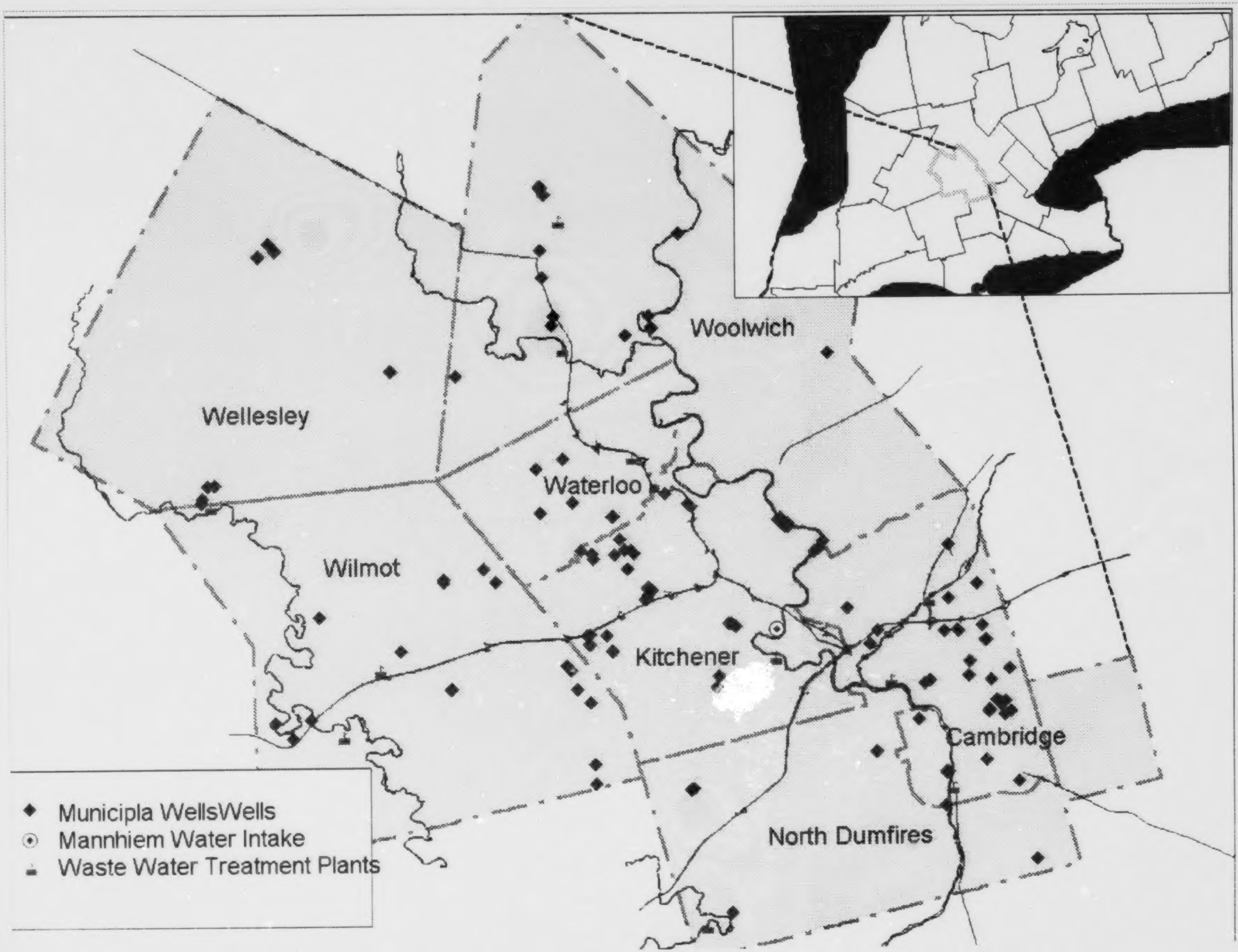
OURS TO PROTECT

RURAL WATER QUALITY PROGRAM

Rural Water Quality Program

- Locally developed program, in consultation with the agricultural community
- First time a municipality has directly funded a non-point source pollution control program
- Innovative approach to addressing water quality
- Viewed as a model for the province

Regional Municipality of
Waterloo


Woolwich
Wellesley
Waterloo
Wilmot
Kitchener
Cambridge
North Dumfires
◆ Municipla WellsWells
⊙ Mannhiem Water Intake
▬ Waste Water Treatment Plants

Water Quality Issues

- microorganisms
- phosphorus
- nitrogen
- sediment

Regional Municipality of Waterloo

Water Quality Benefits

- Secure safe water supply for municipal and private users
- Ensures wastewater treatment effectiveness
- Improves river based recreation and tourism opportunities
- Protects and improves aquatic habitat.

Regional Municipality of
Waterloo

Program Strucutre

- Region of Waterloo
  - Funding $1.5 million over 5 years
  - Program Management
- Grand River Conservation Authority
  - In-kind Funding
  - Program Delivery
- Local Farming Groups
  - Steering Committee
  - Application Review

Regional Municipality of
Waterloo

Program Structure

- Grants
  - 50 to 75 %
  - $25,000 maximum
- Examples
  - Livestock access restriction
  - Milkhouse and manure storage
  - Wellhead protection

Regional Municipality of Waterloo

Program Structure

- Grants Plus Performance Incentives:
  - Per acre basis for up to 3 years
  - Up to $2,500 per year

Performance Incentives

- Erosion control structures
- Cropping practices
- Nutrient management practice

Steering Committee

- 11 local farm groups
- 5 provincial farm groups
- 3 provincial ministries
- 1 federal ministry
- 2 lower tier municipalities
- Region and GRCA

Partnership Benefits

- Involve farmers at the initial stages
- Build consensus
- Create allies and champions of the program
- Develop spokespeople in the community

Program Innovations

- Reliance on the Environmental Farm Plan
- 3 year performance incentive for non capital BMP's
- In-kind labour allowable for fencing
- Cross compliance between sections of the program

This farm has an
ONTARIO
ENVIRONMENTAL
FARM PLAN

Regional Municipality of Waterloo

Program Achievements

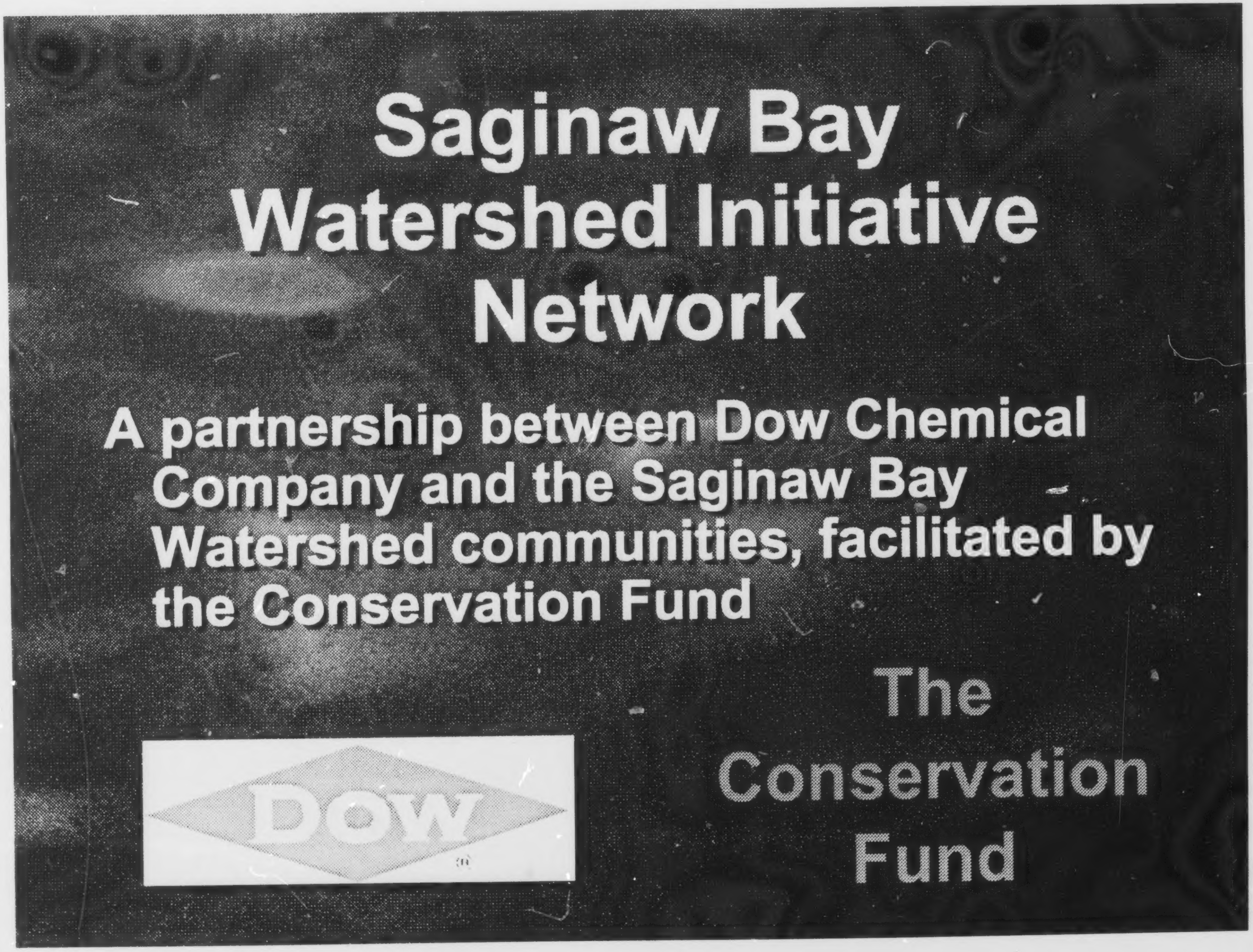
- Over 100 projects completed
- Over $500,000 of grants provided
- $1.2million of capital investment
- $85,000 in-kind provided by the landowner
- Increased EFP participation

Regional Municipality of
Waterloo

Program Accomplishments

- Cost-effective water quality improvement
- Improved water quality and ecosystem
- Adopted by other municipalities
  - Wellington County/City of Guelph RWQP
- Healthy rural economy
- Created sustainable partnerships

Regional Municipality of Waterloo



Saginaw Bay Watershed Initiative Network

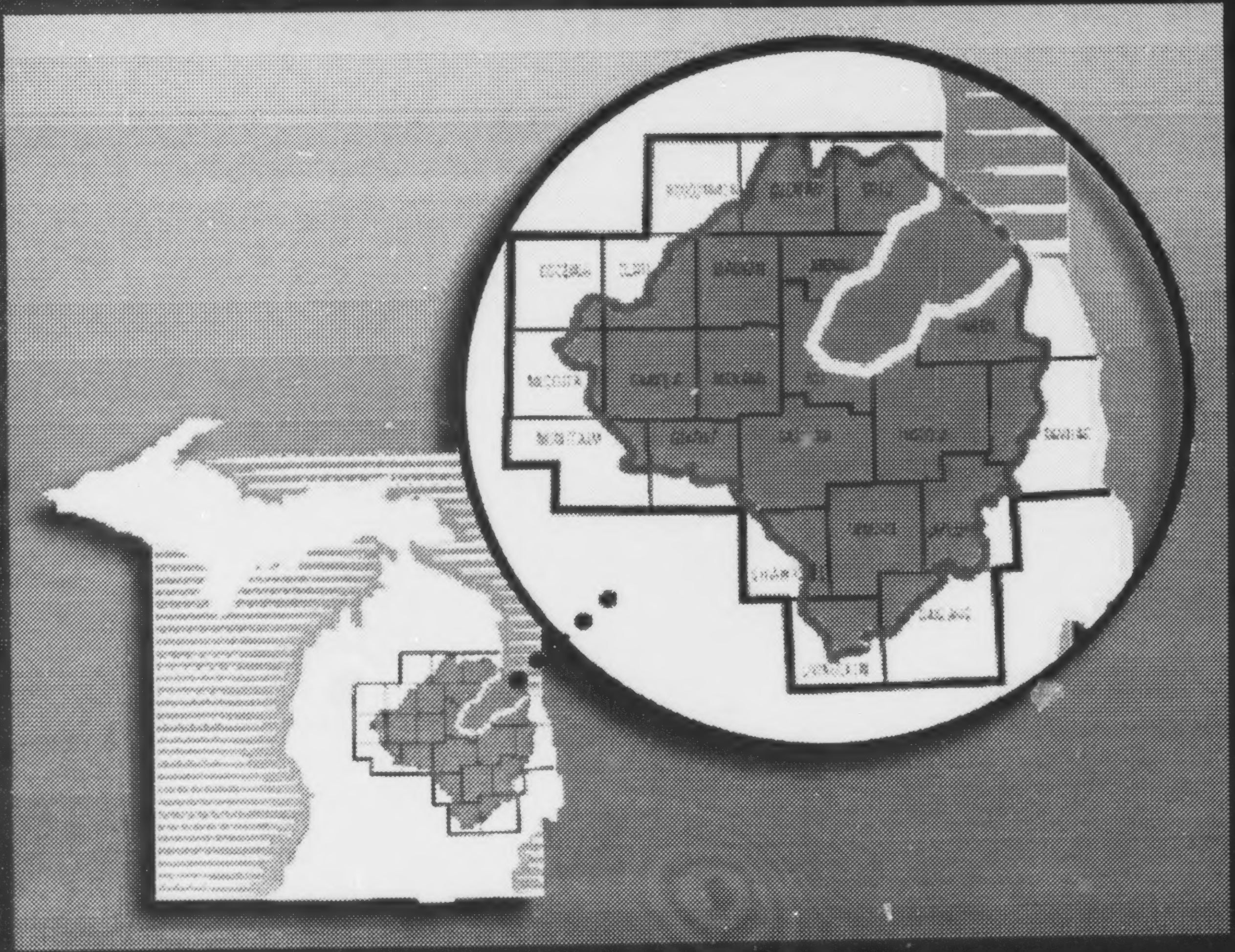
A partnership between Dow Chemical Company and the Saginaw Bay Watershed communities, facilitated by the Conservation Fund

The
Conservation
Fund

Saginaw Bay Watershed Initiative Network

- "WIN" was launched in 1996
- Created to enhance quality of life in the Saginaw Bay watershed

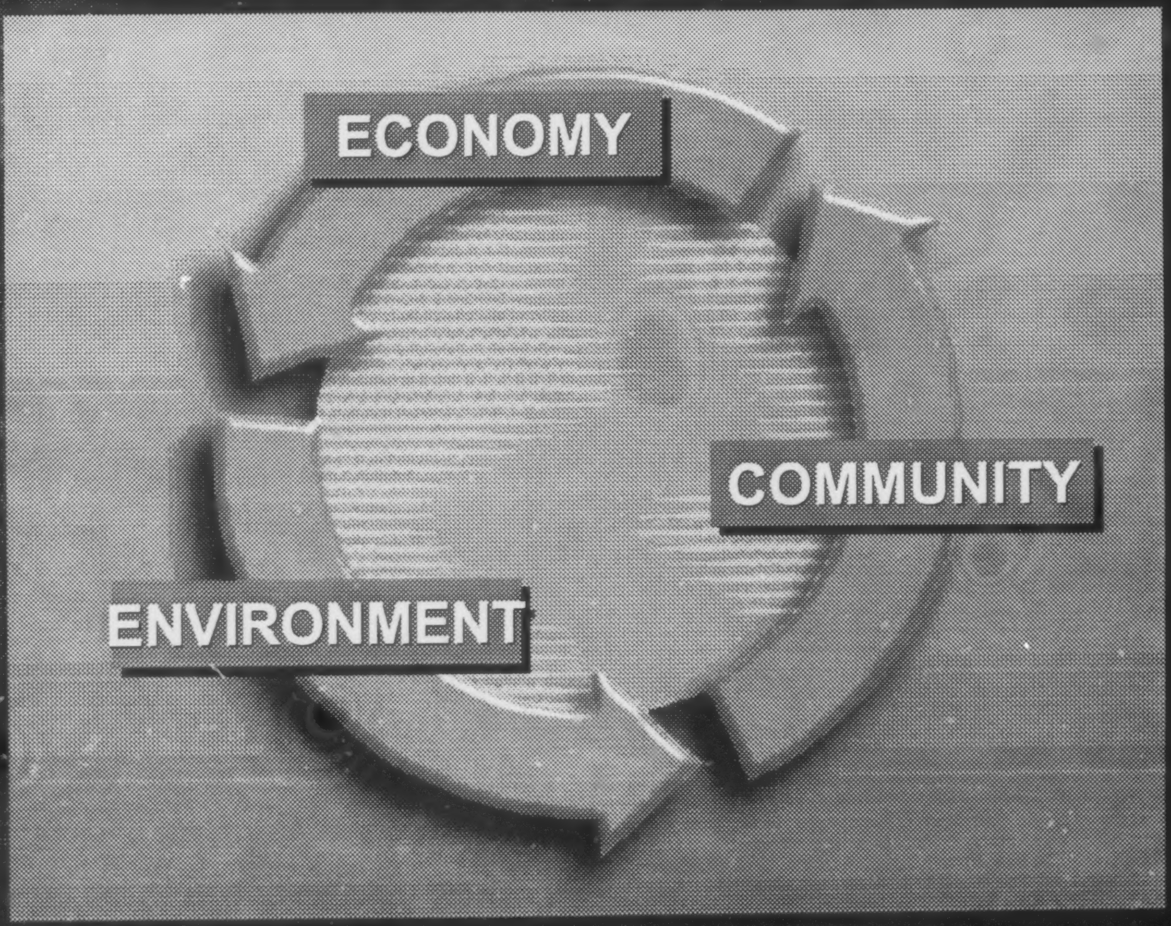
The Saginaw Bay Watershed



What is WIN?

- Community based
- Diverse, volunteer organization
- Action platform for sustainable thinking

Sustainability



ECONOMY

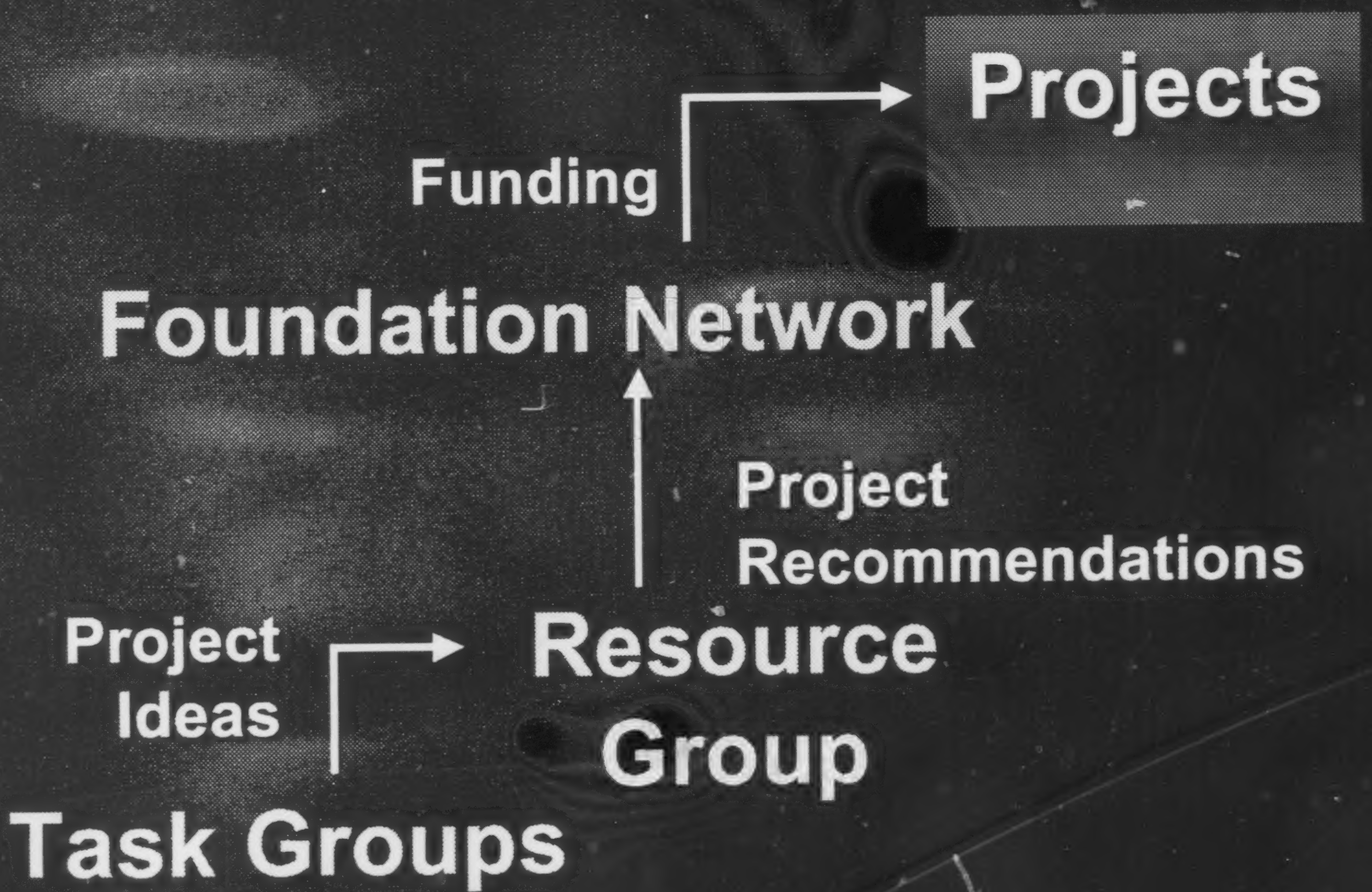
COMMUNITY

ENVIRONMENT

WIN Members

- 90+ Resource Group members
- 25+ additional volunteers on Task Groups
- 13 foundations in Foundation Network

Funding Process



Projects

Funding

Foundation Network

Project
Recommendations

Resource
Group

Project
Ideas

Task Groups

WIN Structure

Foundation Network

- 13 member foundations
- Community & private foundations
- Established $300,000/year seed fund for WIN projects

Foundation Network

- Bay Area Community Foundation
- Charles J. Strosacker Foundation
- Consumers Energy Foundation
- Harry A. and Margaret D. Towsley Foundation
- Kantzler Foundation
- Midland Foundation
- Rollin M. Gerstacker Foundation
- Saginaw Community Foundation
- S.C. Johnson Fund
- The Charles Stewart Mott Foundation
- The Dow Chemical Company Foundation
- The Herbert H. and Grace A. Dow Foundation
- Cook Family Fund

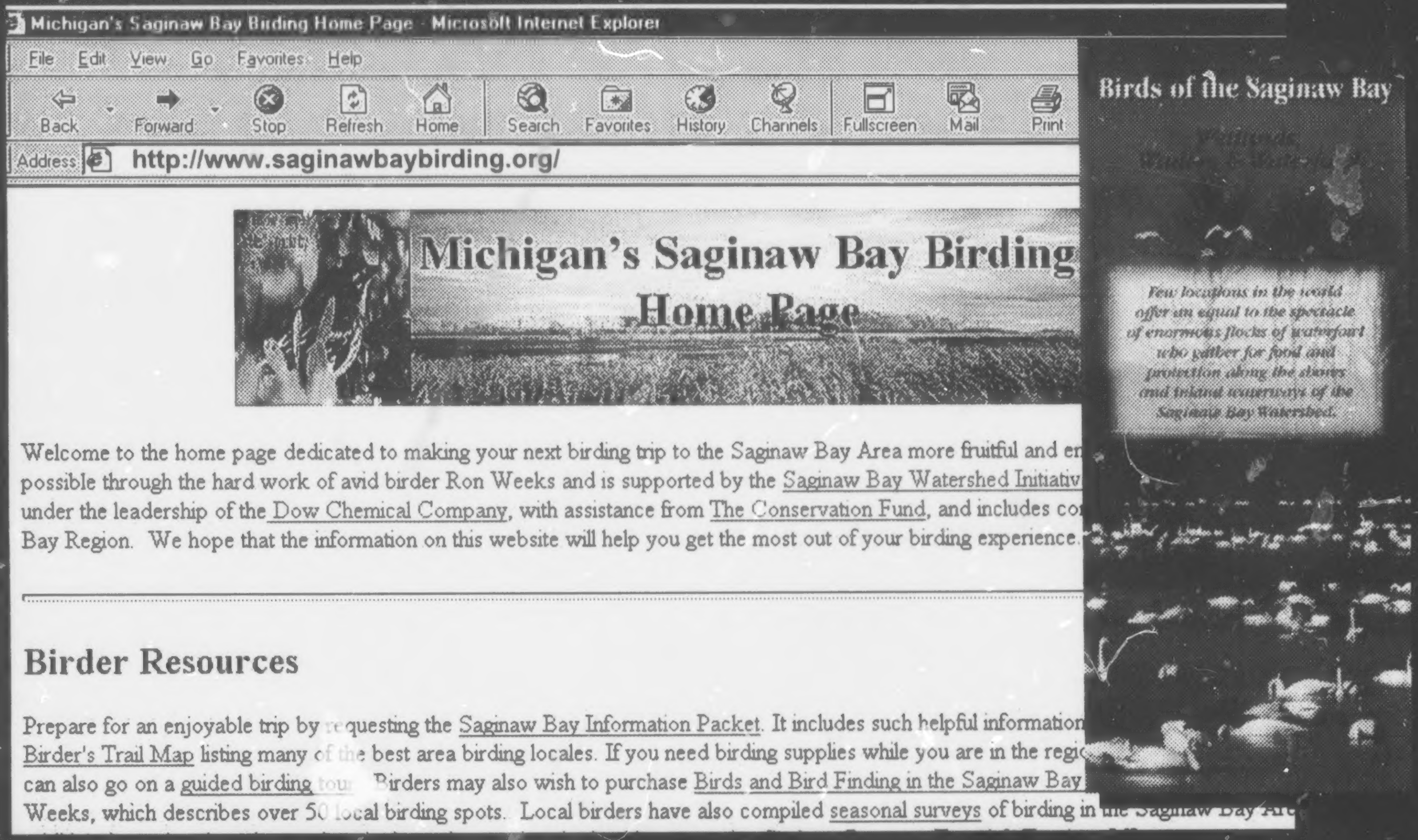
Land Use Objectives

- Smart community growth
- Profitable, environmentally sound building & development practices
- Open space & farmland protection

Wildlife Stewardship Projects

- Habitat enhancement, protection
- Market region as nature-based tourism destination
- Public access

Birding Brochure & Website


Michigan's Saginaw Bay Birding Home Page - Microsoft Internet Explorer
File
Edit
View
Go
Favorites
Help
Back
Forward
Stop
Refresh
Home
Search
Favorites
History
Channels
Fullscreen
Mail
Print
Address

http://www.saginawbaybirding.org/

Michigan's Saginaw Bay Birding
Home Page

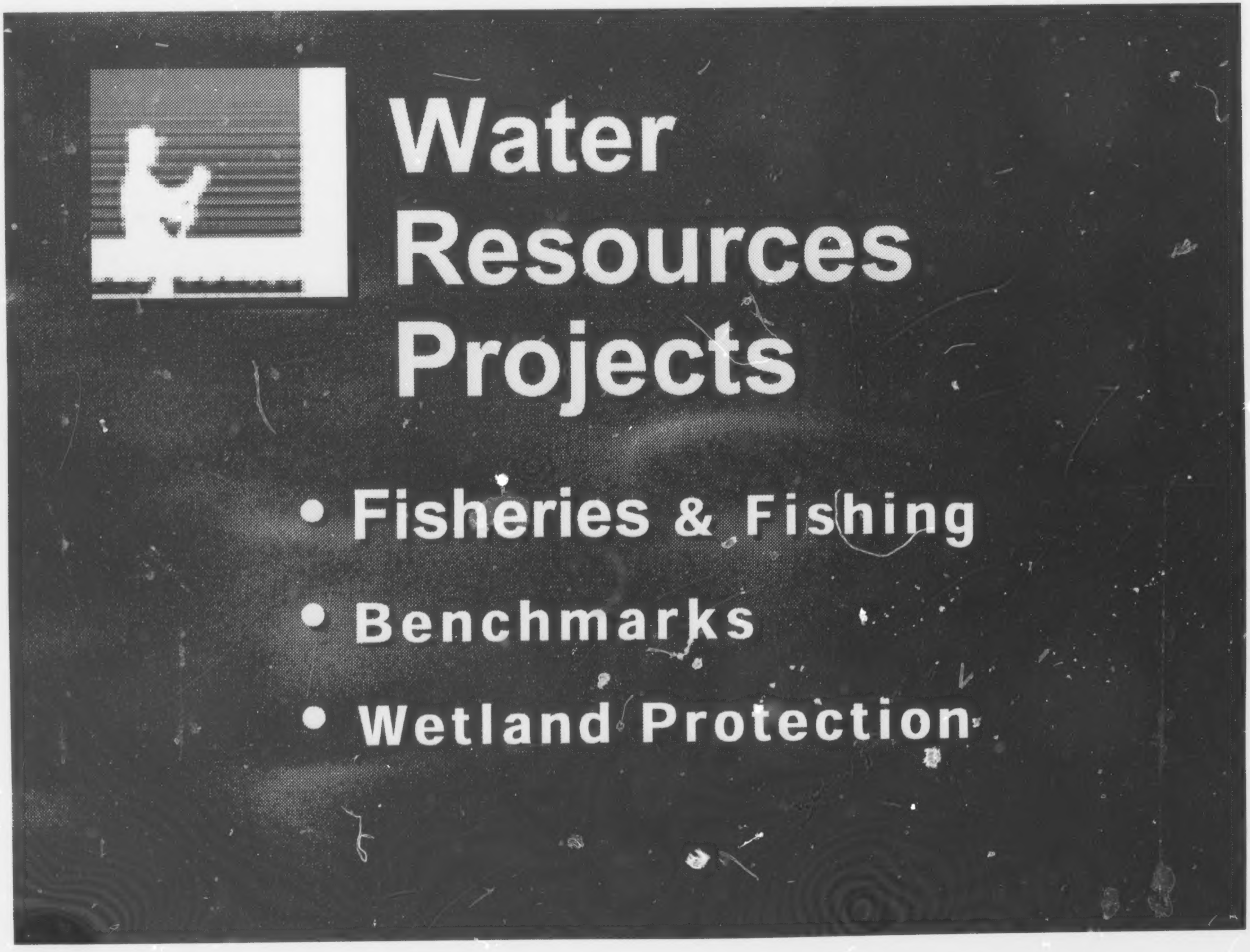
Welcome to the home page dedicated to making your next birding trip to the Saginaw Bay Area more fruitful and en
possible through the hard work of avid birder Ron Weeks and is supported by the Saginaw Bay Watershed Initiativ
under the leadership of the Dow Chemical Company, with assistance from The Conservation Fund, and includes co
Bay Region. We hope that the information on this website will help you get the most out of your birding experience.

Birder Resources

Prepare for an enjoyable trip by requesting the Saginaw Bay Information Packet. It includes such helpful information
Birder's Trail Map listing many of the best area birding locales. If you need birding supplies while you are in the regi
can also go on a guided birding tour. Birders may also wish to purchase Birds and Bird Finding in the Saginaw Bay
Weeks, which describes over 50 local birding spots. Local birders have also compiled seasonal surveys of birding in the Saginaw Bay Are

Birds of the Saginaw Bay

Few locations in the world offer an equal to the spectacle of enormous flocks of waterfowl who gather for food and protection along the shores and inland waterways of the Saginaw Bay Watershed.



Water Resources Projects

- Fisheries & Fishing
- Benchmarks
- Wetland Protection

Agriculture/P2 Objectives

- Improve farm profitability
- Reduce runoff & soil loss
- Support farm communities

How Can I Get Involved?

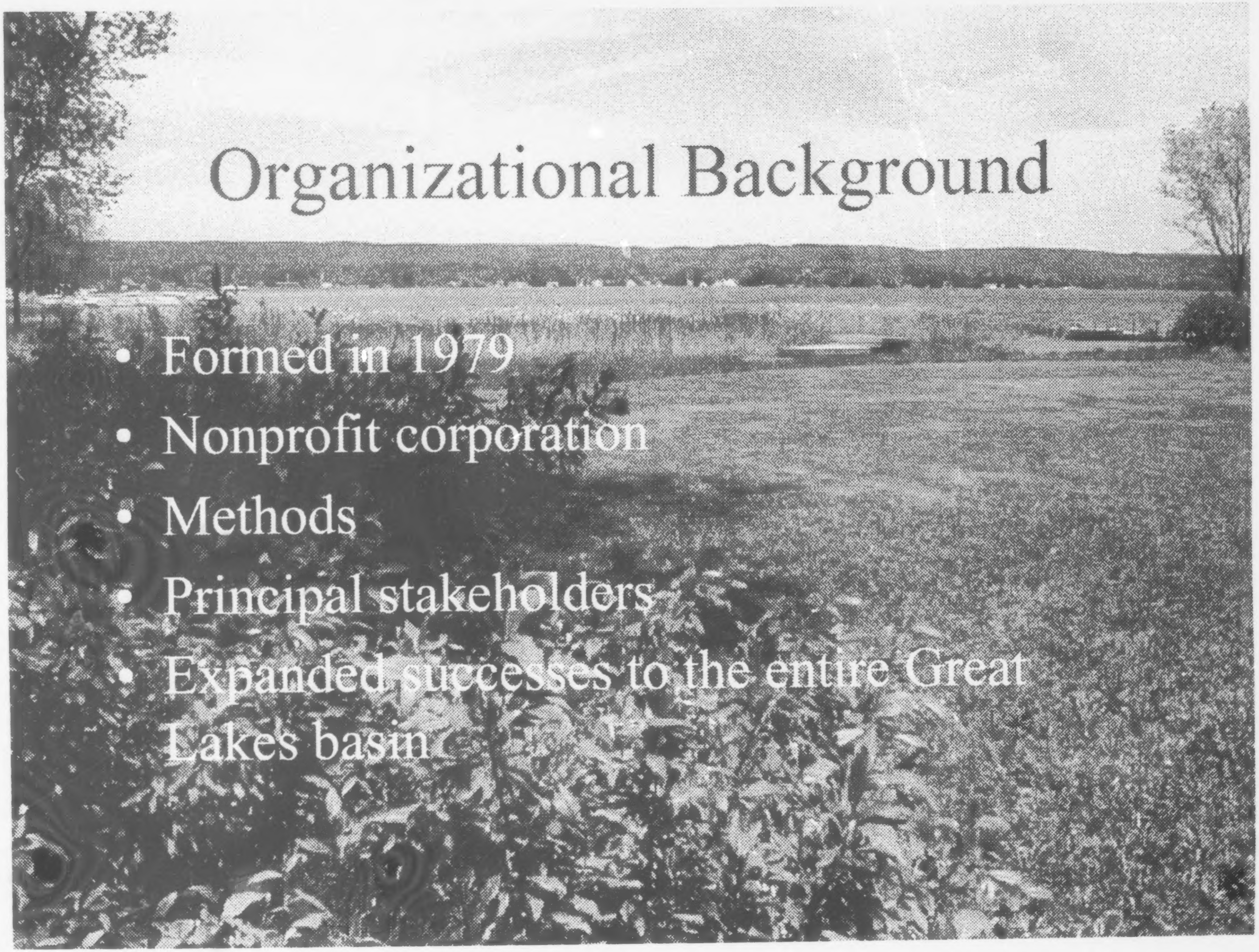
Visit WIN website at:
www.saginawbaywin.org

Call WIN toll free at:
1-877-ASK-4WIN

TIP OF THE MITT

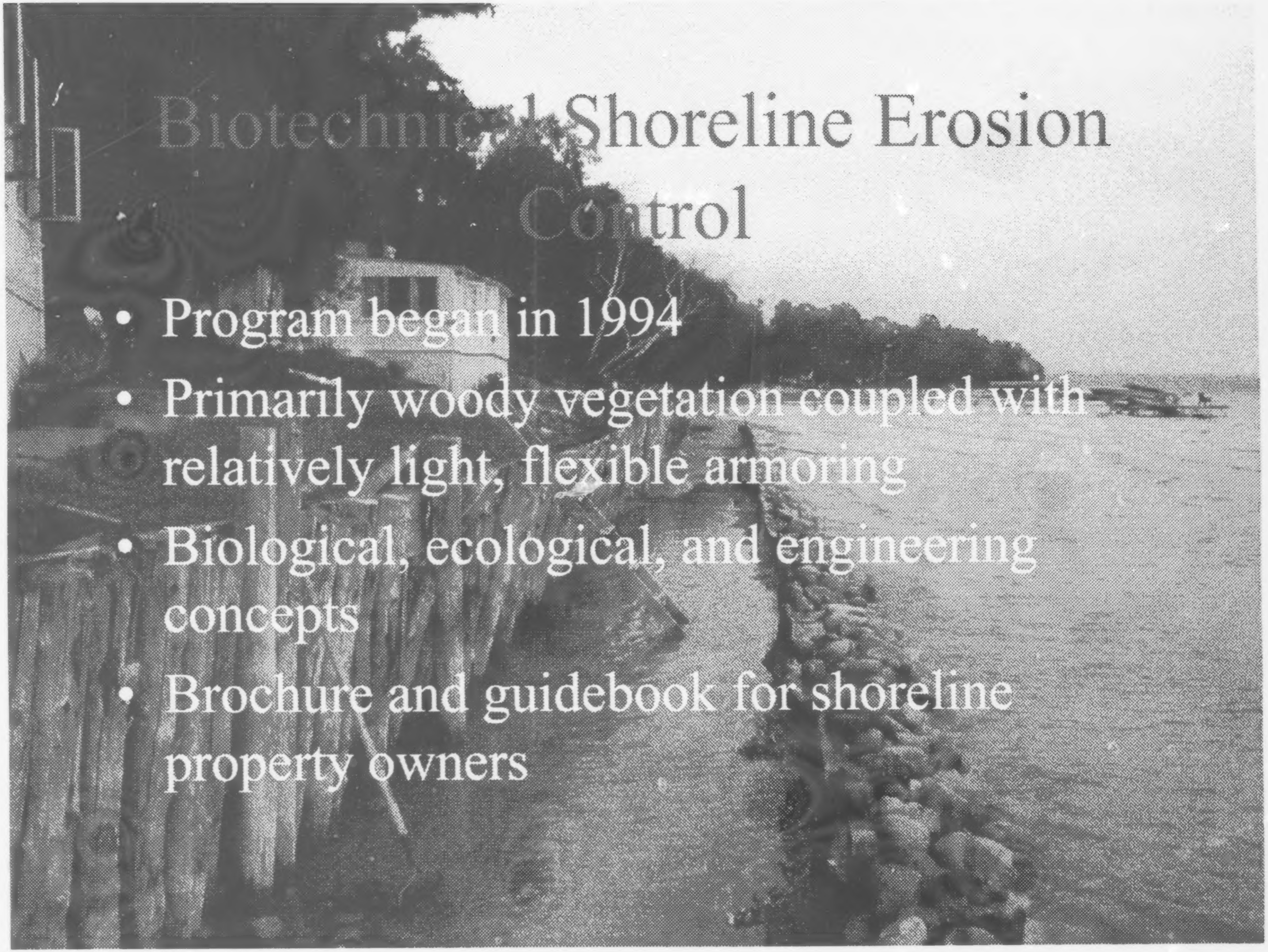
Watershed Council

Jill Ryan



Organizational Background

- Formed in 1979
- Nonprofit corporation
- Methods
- Principal stakeholders
- Expanded successes to the entire Great Lakes basin



Biotechnical Shoreline Erosion Control

- Program began in 1994
- Primarily woody vegetation coupled with relatively light, flexible armoring
- Biological, ecological, and engineering concepts
- Brochure and guidebook for shoreline property owners

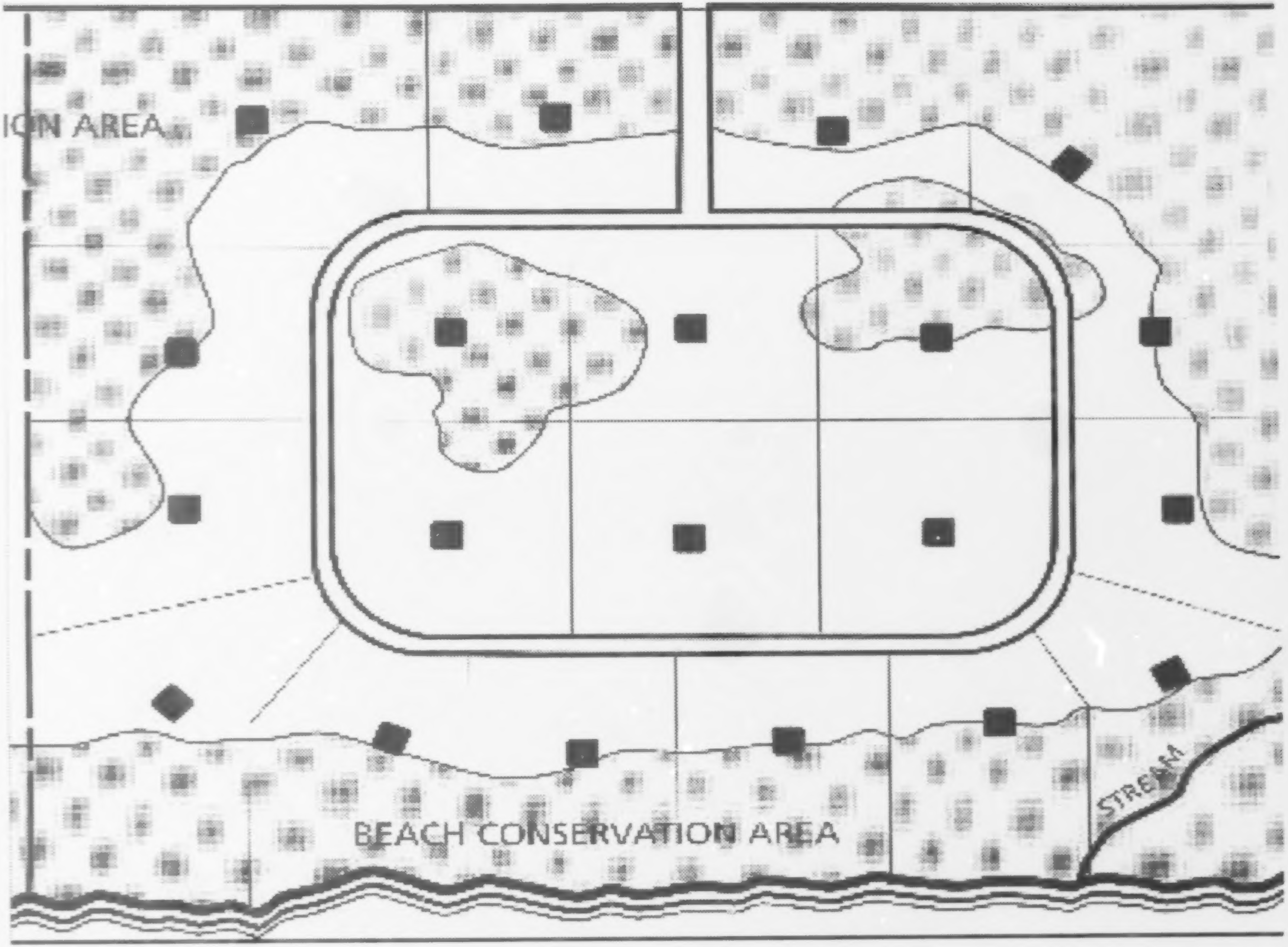
Biotechnical Shoreline Erosion Control

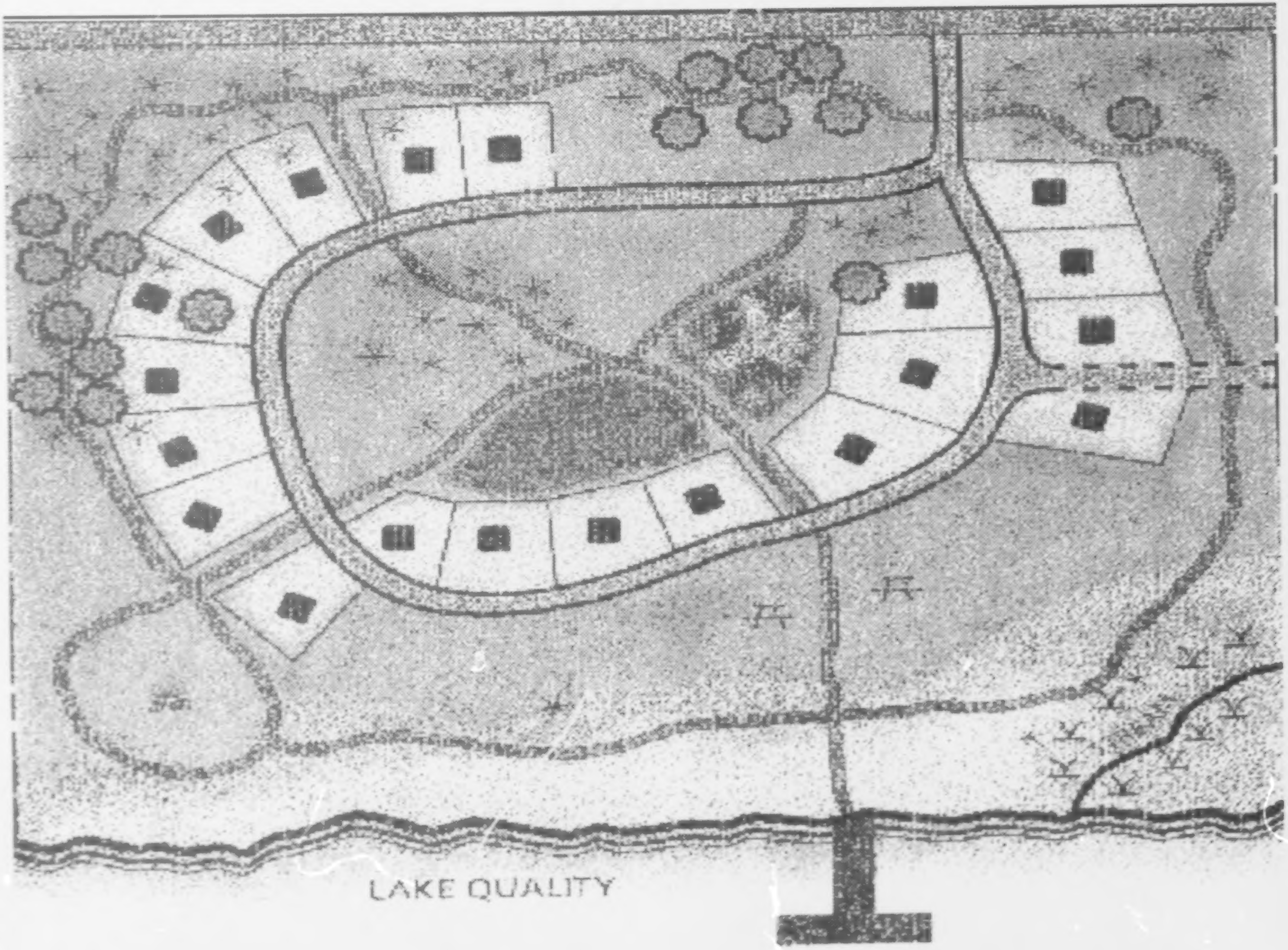
- Projects at about 10 sites per year
- Protects both water quality and the investments of property owners
- Prevented an estimated 270 tons of sediments to date
- Restores wildlife habitat, improves appearance, helps prevent overland runoff, and takes up nutrients
- Shoreline erosion assessments and recommendations

rosion Control &
abitat Restoration
roject
By:

Conservation Planning and Design

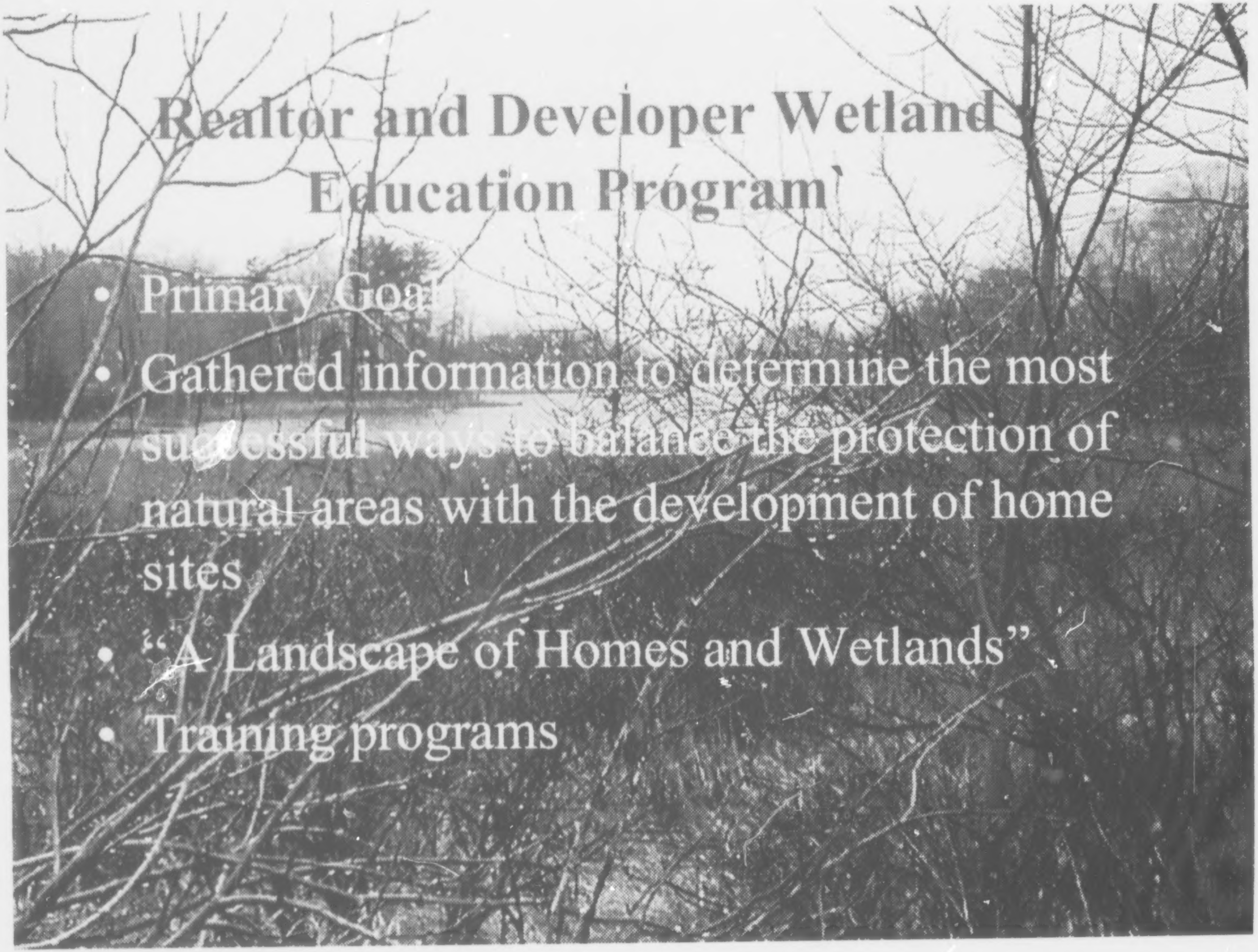
- Project Goal
- Developed a conservation planning implementation manual
- Attempts to preserve a minimum of 50% of the property in open space,
- Follow-up projects
- Demonstration sites


ION AREA
BEACH CONSERVATION AREA
STREAM


LAKE QUALITY

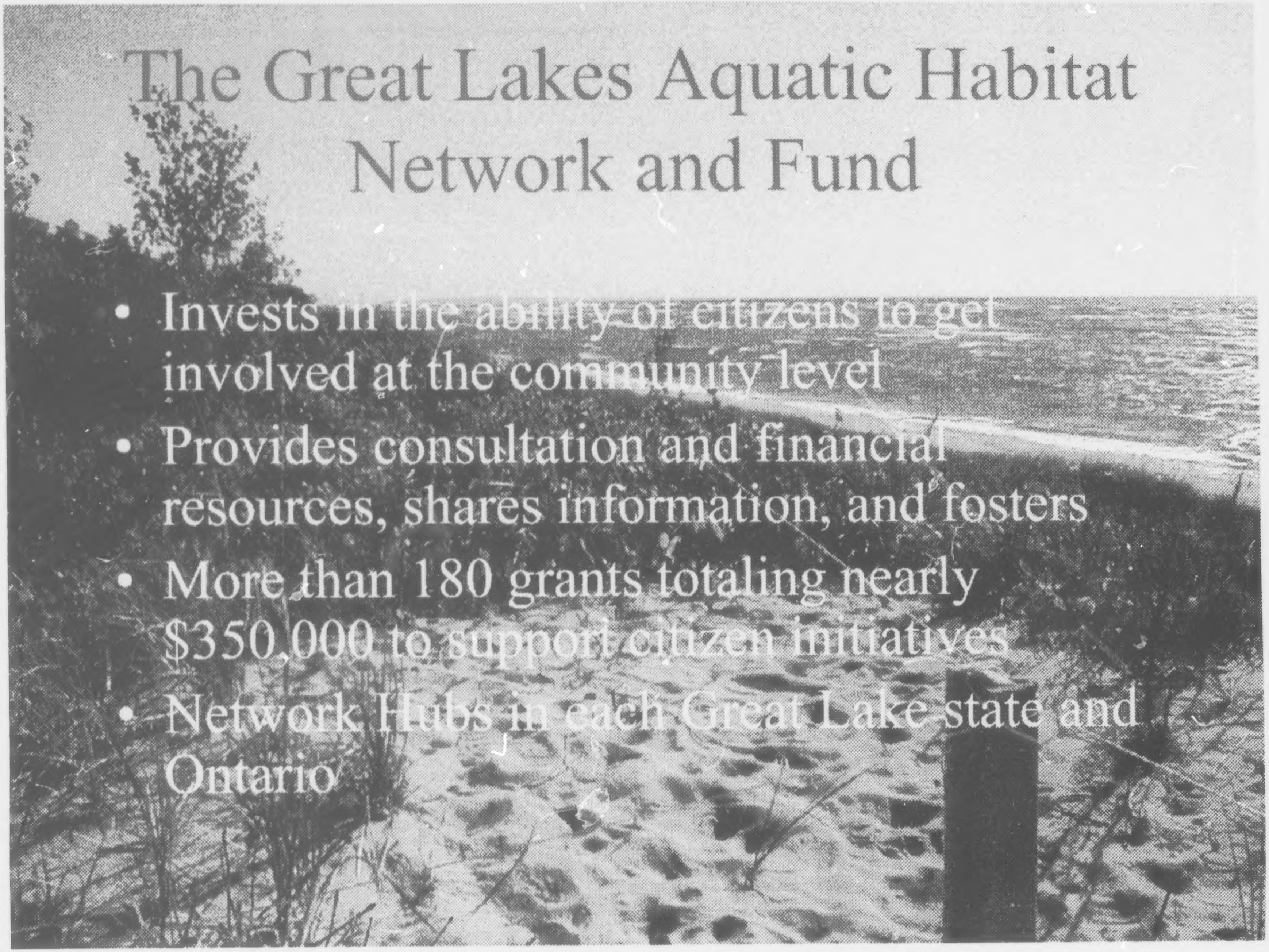
Watershed Planning and Implementation Projects

- Promoted and modeled watershed management as the best method to protect water quality and aquatic habitats
- Implementation activities
- Managing water resources from a watershed perspective provides:
  - Long-term protection
  - Greater understanding of our spectacular water resources



Realtor and Developer Wetland Education Program`

- Primary Goal
- Gathered information to determine the most successful ways to balance the protection of natural areas with the development of home sites
- "A Landscape of Homes and Wetlands"
- Training programs



The Great Lakes Aquatic Habitat Network and Fund

- Invests in the ability of citizens to get involved at the community level
- Provides consultation and financial resources, shares information, and fosters
- More than 180 grants totaling nearly $350,000 to support citizen initiatives
- Network Hubs in each Great Lake state and Ontario

XEROX
Environmental Leadership

Anne Stocum
Environment, Health & Safety
Xerox Corporation

10/00

Environmental Leadership Program

Goal

Waste-free products manufactured in Waste-Free factories to enable our customers to achieve Waste-Free offices

Waste-Free Programs
Great Lakes Ecosystem

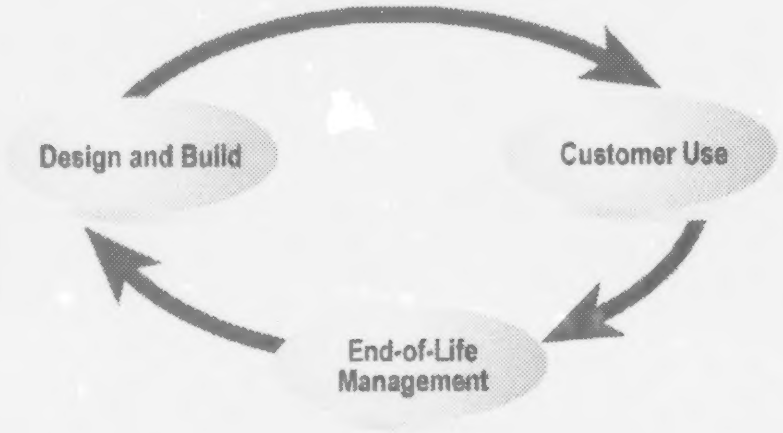
0
100mi
100km
Quebec
Sault Ste. Marie
Sudbury
North Bay
Trois-Rivières
Ottawa
Montréal
Huntsville
Cornwall
Owen Sound
Barrie
Peterborough
Montpelier
Toronto
Concord
Flint
London
Buffalo
Albany
Boston
Detroit
Erie
Hartford
Toledo
Cleveland
New Haven
Akron
Paterson
New York
Pittsburgh
Harrisburg
Columbus
Philadelphia

- Xerox's largest manufacturing facility is located in Webster, NY

Environmental Leadership Program

Goal

Waste-free products manufactured in Waste-Free factories to enable our customers to achieve Waste-Free offices


Design and Build
Customer Use
End-of-Life Management

- Reduce waste & emissions
- Minimal use of hazardous substances

- Paper savings features
- Energy-efficiency
- Returns programs for consumables

- Equipment Takeback & Remanufacturing
- Parts reuse & recycling

Waste-Free Factories

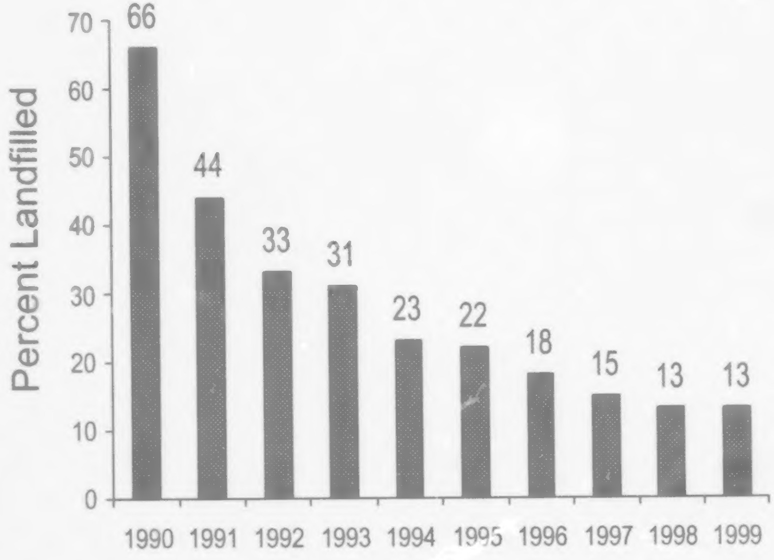
Criteria

- 90% reduction in solid waste to landfills
- 90% reduction in air emissions
- 90% reduction in hazardous waste
- Incorporate 25% post-consumer recycled materials in parts and packaging
- Energy usage within 10% of optimum level for facility

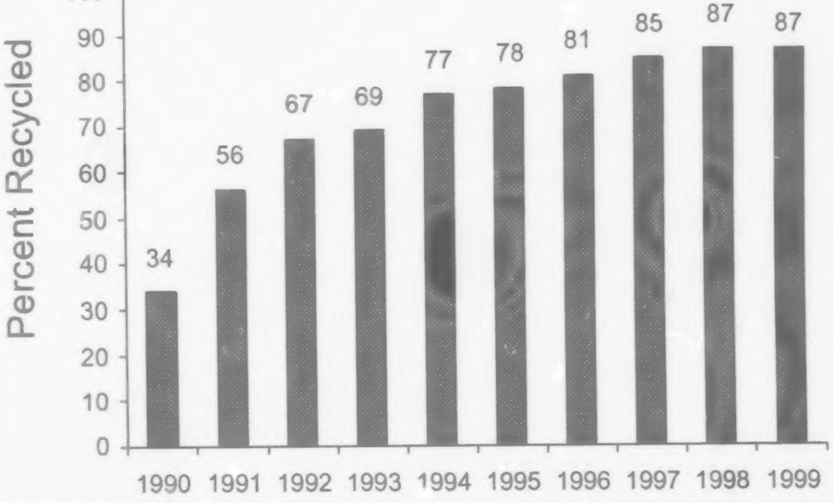
(Baseline: 1990 levels)

Waste Free Factories
Solid Waste Landfill Reductions

Percent Landfilled
80% decrease since 1990



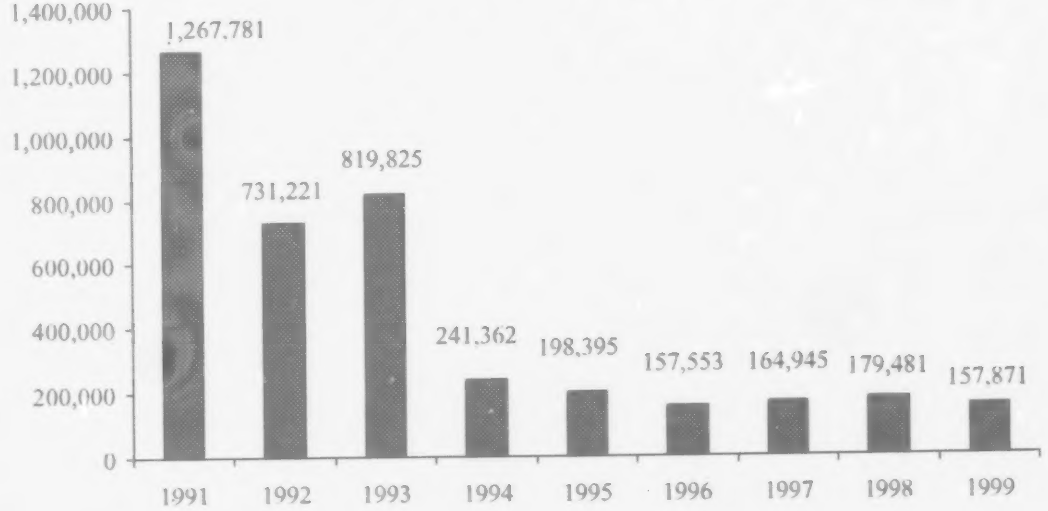
Percent Recycled, Reused
156% increase since 1990



Business Result - 3R's: $47 million in 1999

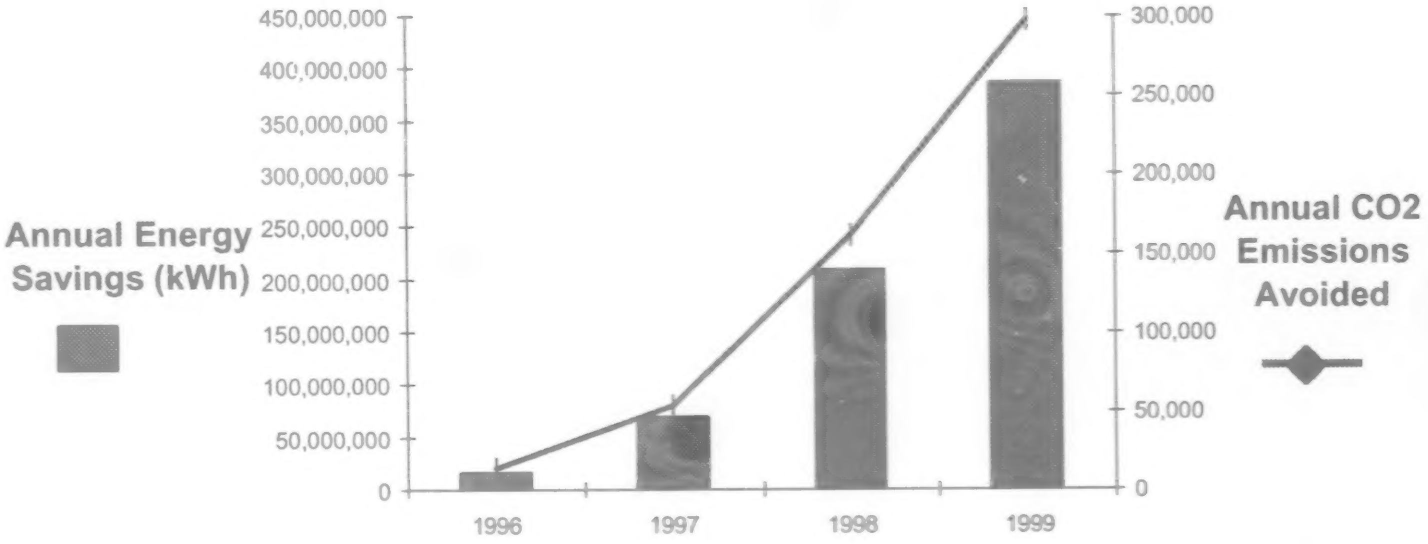
Waste Free Factories
TRI Releases Reduction (U.S.)

- 27% reduction in Total TRI Releases To Environment between 1998 and 1999
- Releases to Environment decreased 88% since 1991



- Dichloromethane emissions reduced 10-fold since 1991

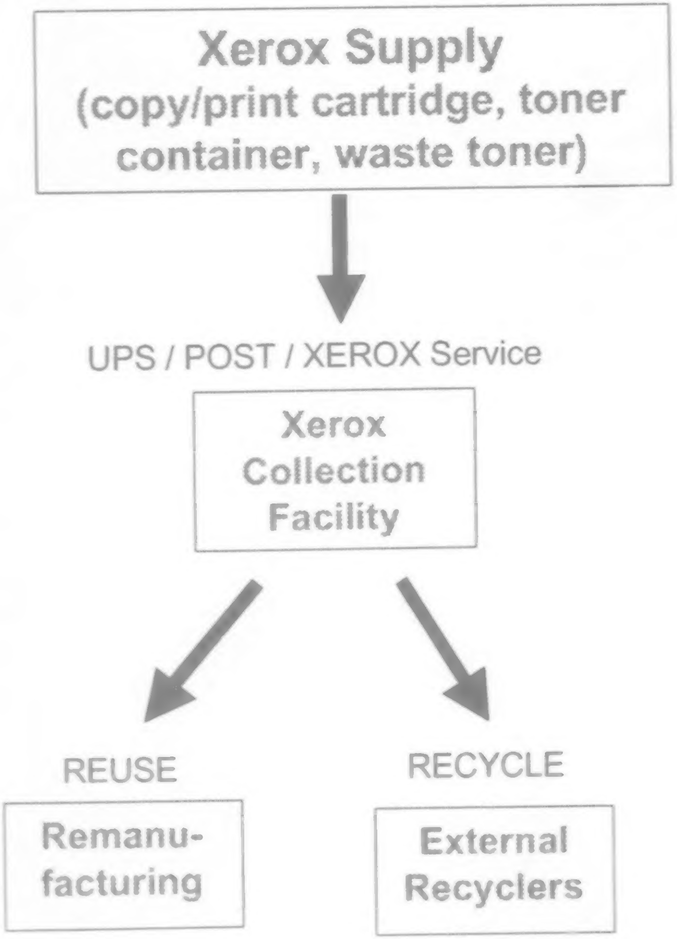
Waste Free Products
Energy Savings



Environmental Benefits of Xerox ENERGY STAR Machines

- 95% of Xerox products launched in 1999 met the requirements of the Energy Star® program

Waste-Free Products
Supplies Returns Programs



Xerox Supply
(copy/print cartridge, toner container, waste toner)

UPS / POST / XEROX Service

Xerox Collection Facility

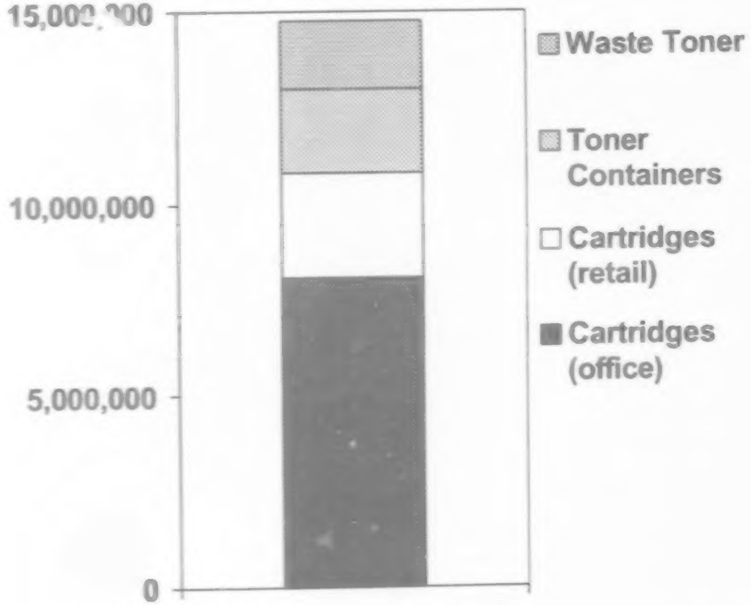
REUSE

Remanu-facturing

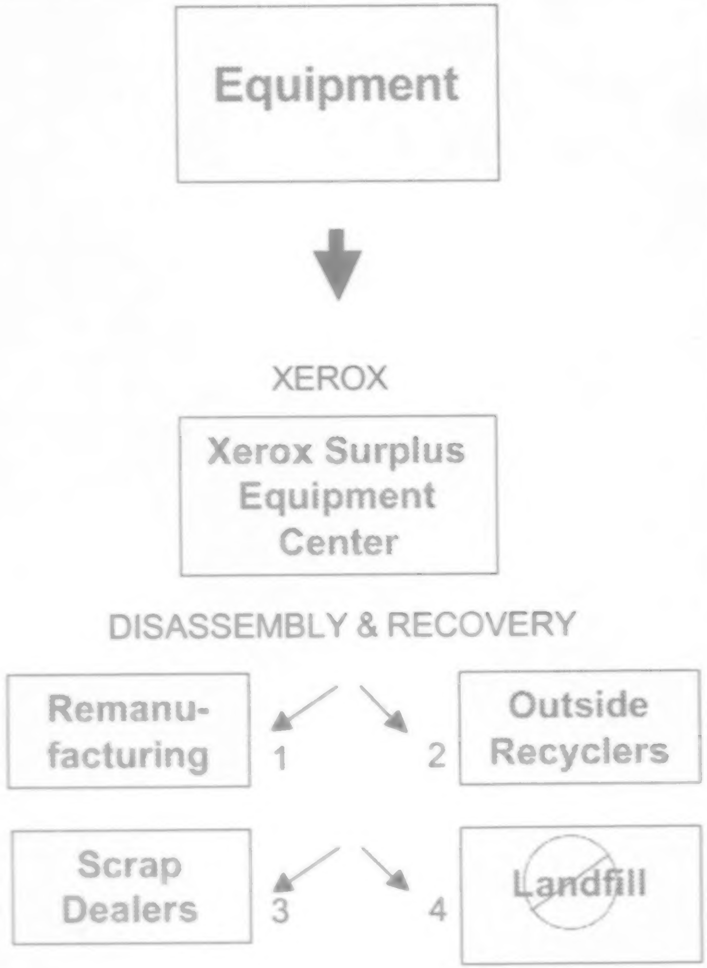
RECYCLE

External Recyclers

- Total Waste Diverted From Landfill: Nearly 15 million pounds



Waste-Free Products
Equipment Remanufacture & Parts Reuse/Recycle



Equipment

XEROX

Xerox Surplus Equipment Center

DISASSEMBLY & RECOVERY

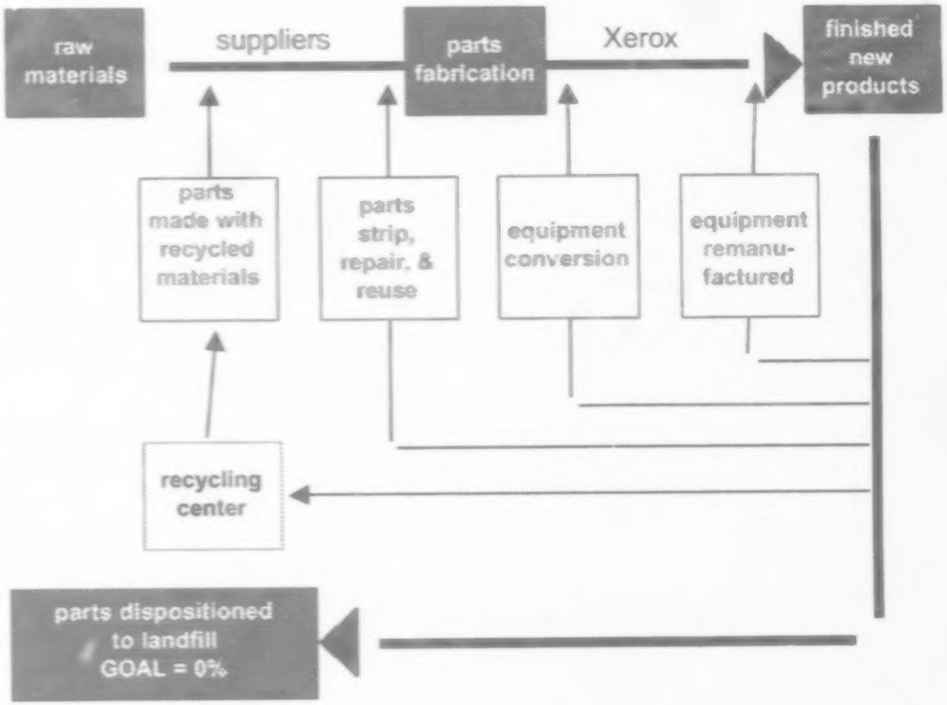
1 Remanu-facturing

2 Outside Recyclers

3 Scrap Dealers

4 ~~Landfill~~

Recycle Process



raw materials

suppliers

parts fabrication

Xerox

finished new products

parts made with recycled materials

parts strip, repair, & reuse

equipment conversion

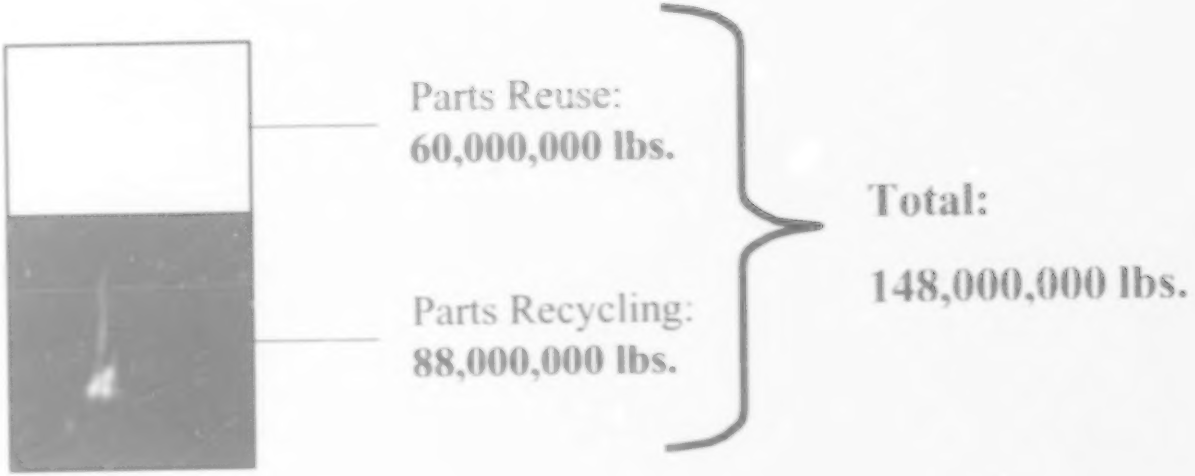
equipment remanu-factured

recycling center

parts dispositioned to landfill GOAL = 0%

Waste-Free Products
Equipment Results

- In 1999, equipment manufacture and parts reuse and recycling diverted almost 150 million pounds of material from landfill



Parts Reuse:
60,000,000 lbs.

Parts Recycling:
88,000,000 lbs.

Total:

148,000,000 lbs.

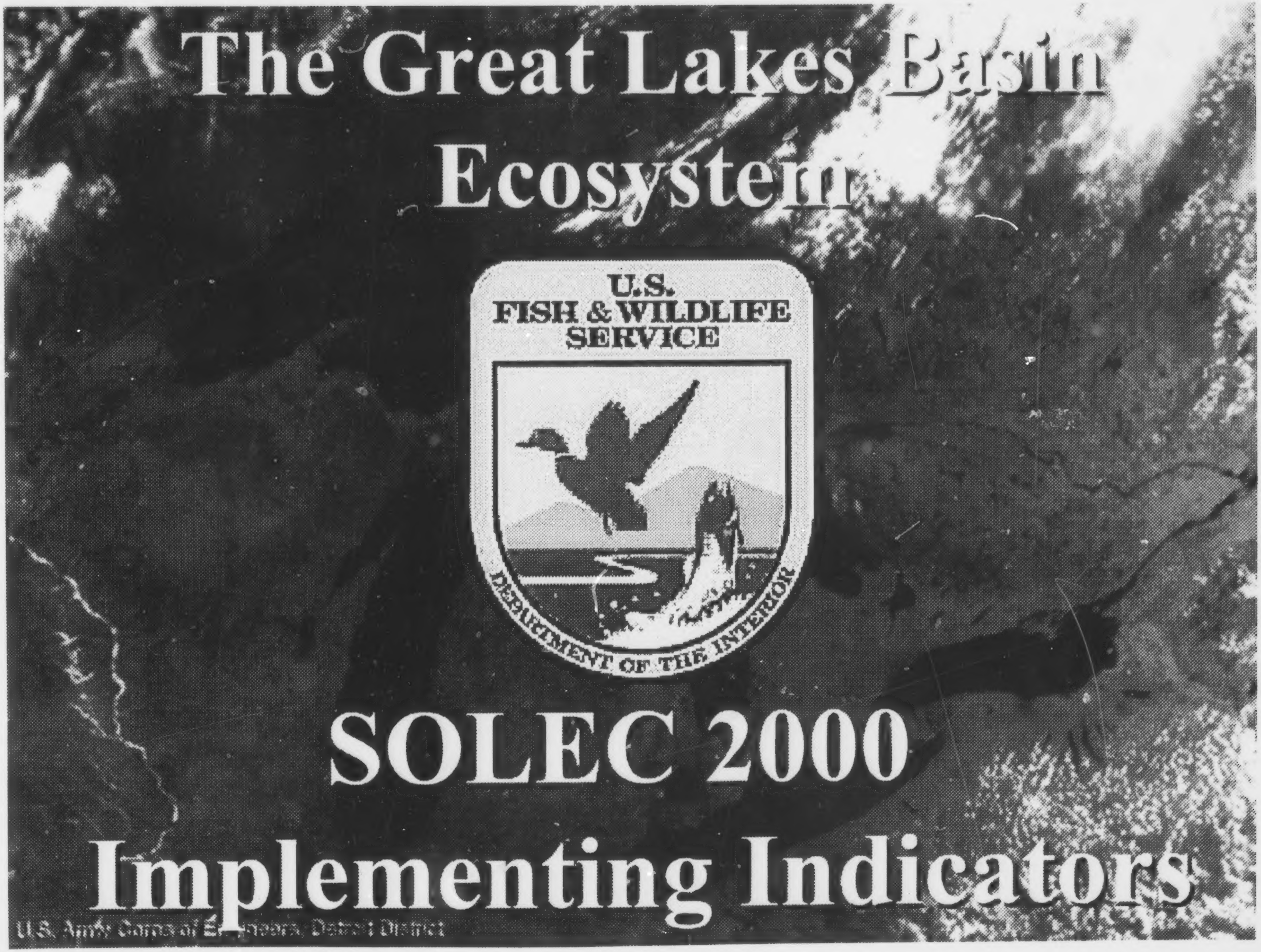
Business Results
Win-Win

Equipment Remanufacturing and Parts Reuse / Recycling

- Several hundred million dollars annually

3R Program

- $47 million in savings in 1999



The Great Lakes Basin Ecosystem

U.S.
FISH & WILDLIFE
SERVICE

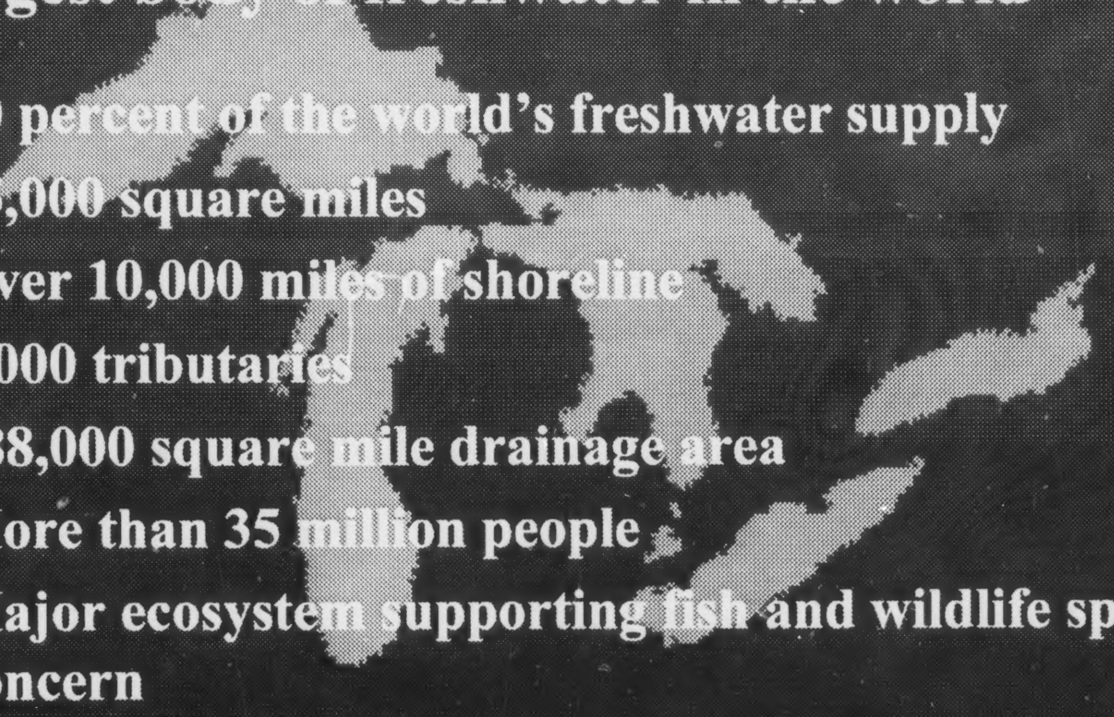
DEPARTMENT OF THE INTERIOR

SOLEC 2000

Implementing Indicators

U.S. Army Corps of Engineers, Detroit District

Great Lakes Ecosystem



Largest body of freshwater in the world

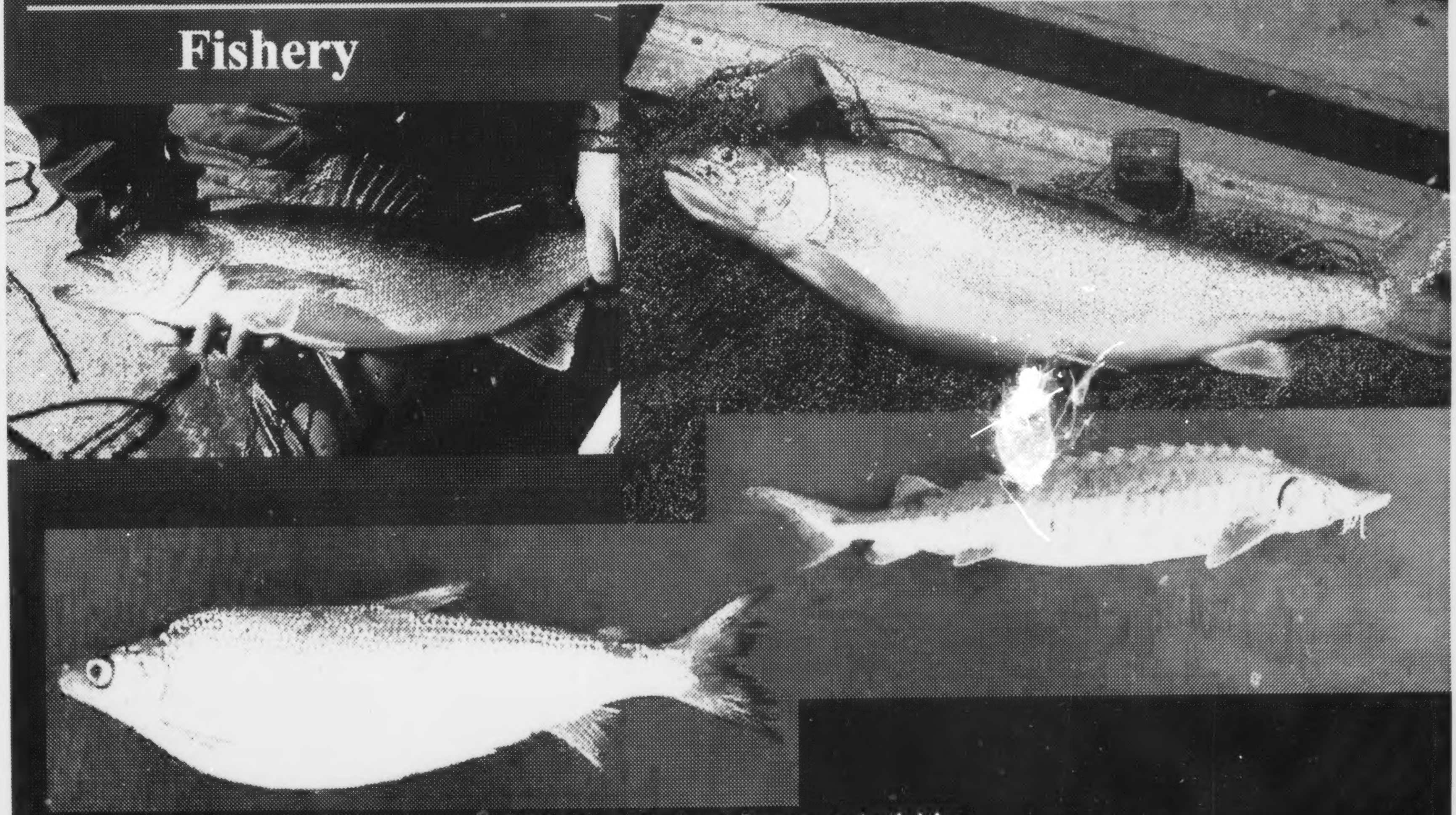
- 20 percent of the world's freshwater supply
- 95,000 square miles
- Over 10,000 miles of shoreline
- 5,000 tributaries
- 288,000 square mile drainage area
- More than 35 million people
- Major ecosystem supporting fish and wildlife species of concern

Division of Federal Program Activities

Great Lakes Ecosystem

SOLEC 2000

Fishery



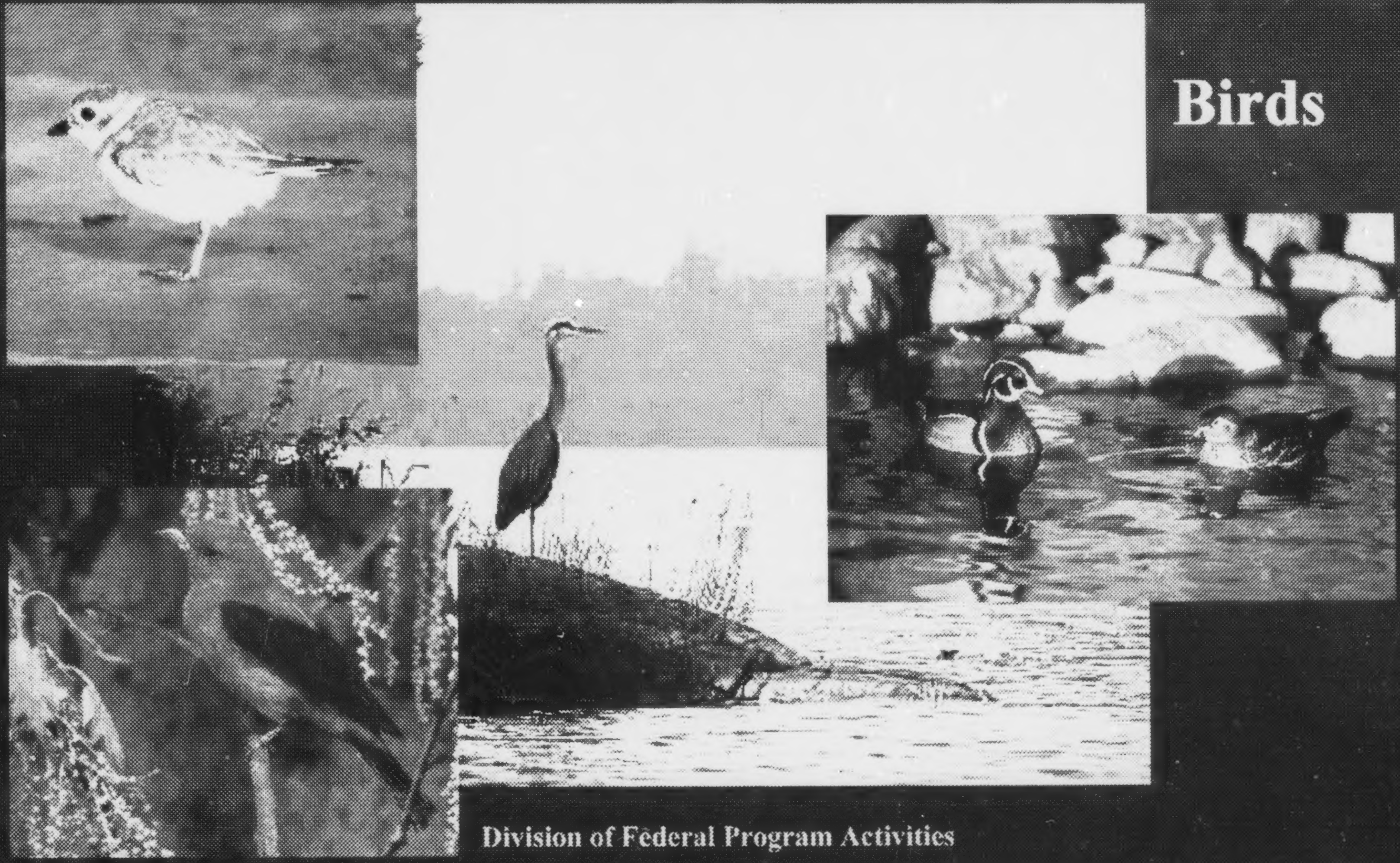
Division of Federal Program Activities

U.S. FISH & WILDLIFE SERVICE

Great Lakes Ecosystem

SOLEC 2000

Birds

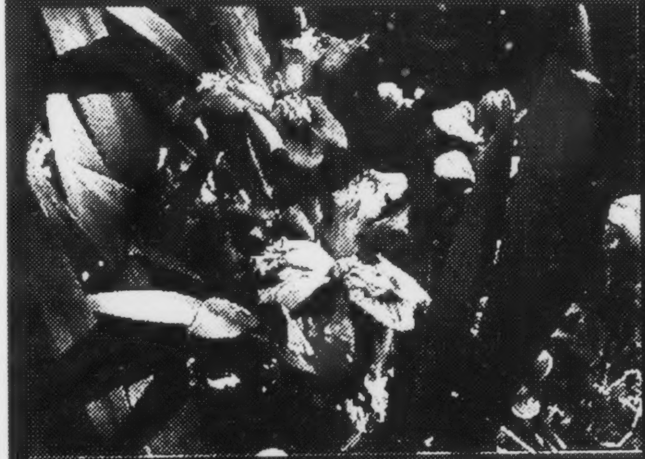
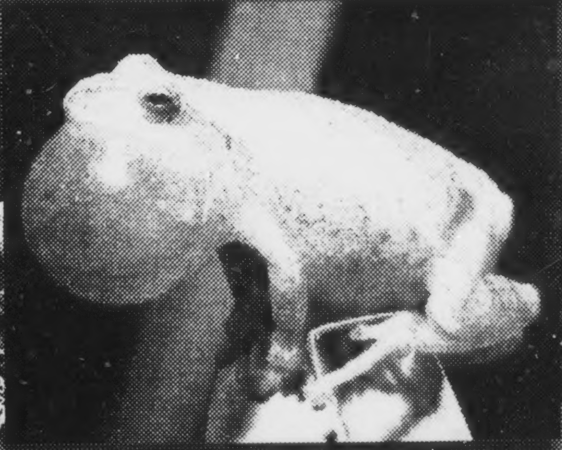


Division of Federal Program Activities

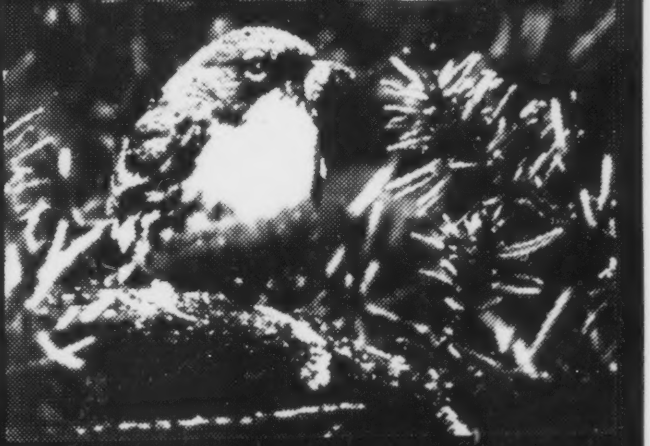
U.S. FISH & WILDLIFE SERVICE

Great Lakes Ecosystem

SOLEC 2000

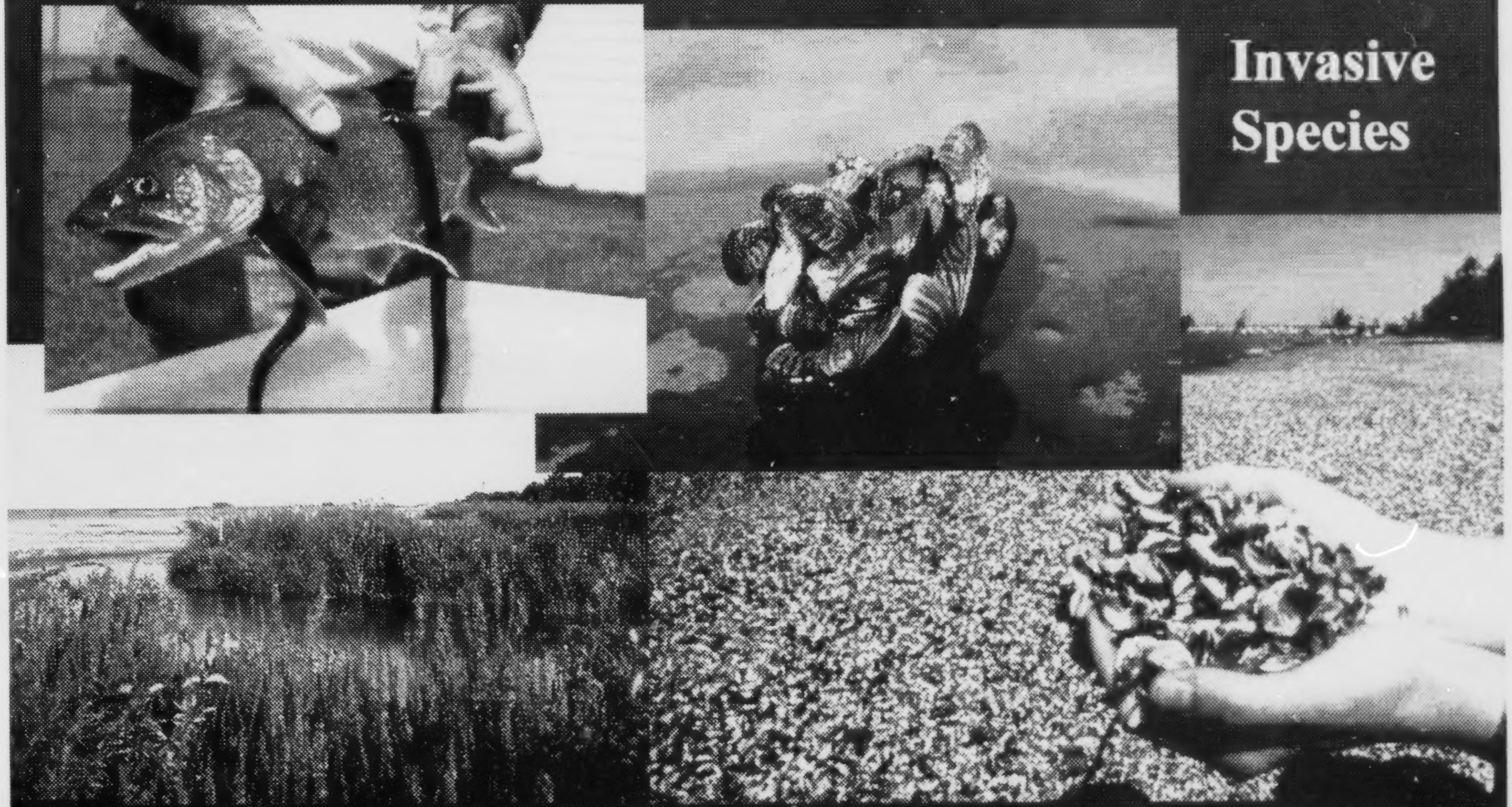
Rare and Threatened Species



Division of Federal Program Activities

Great Lakes Ecosystem

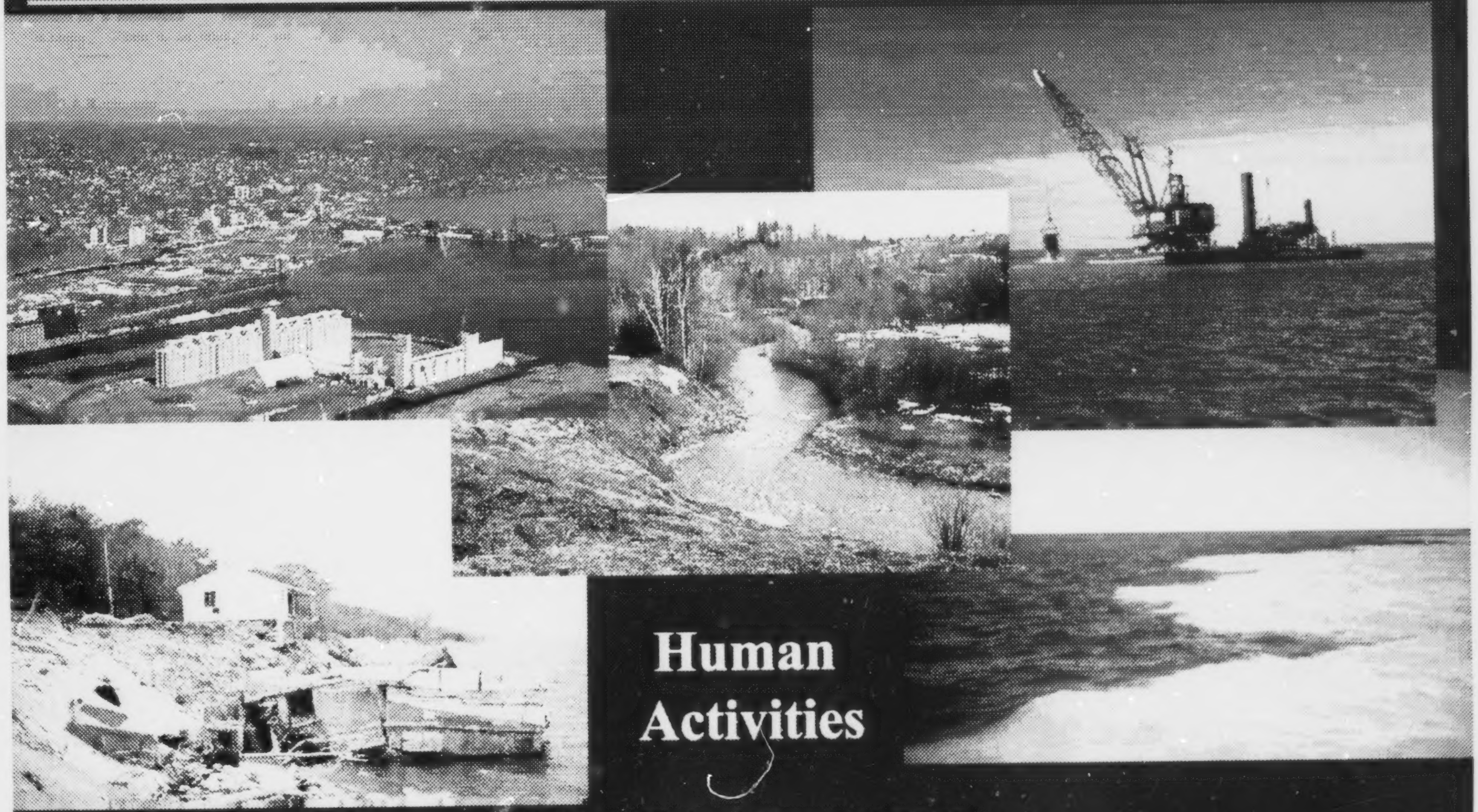
Invasive Species



Division of Federal Program Activities

Great Lakes Ecosystem

SOLEC 2000



Human Activities

Division of Federal Program Activities

Great Lakes Water Quality Agreement

“. . . To restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem.”

FWS Mission

"Working with others, to conserve, protect, and enhance fish, wildlife, and their

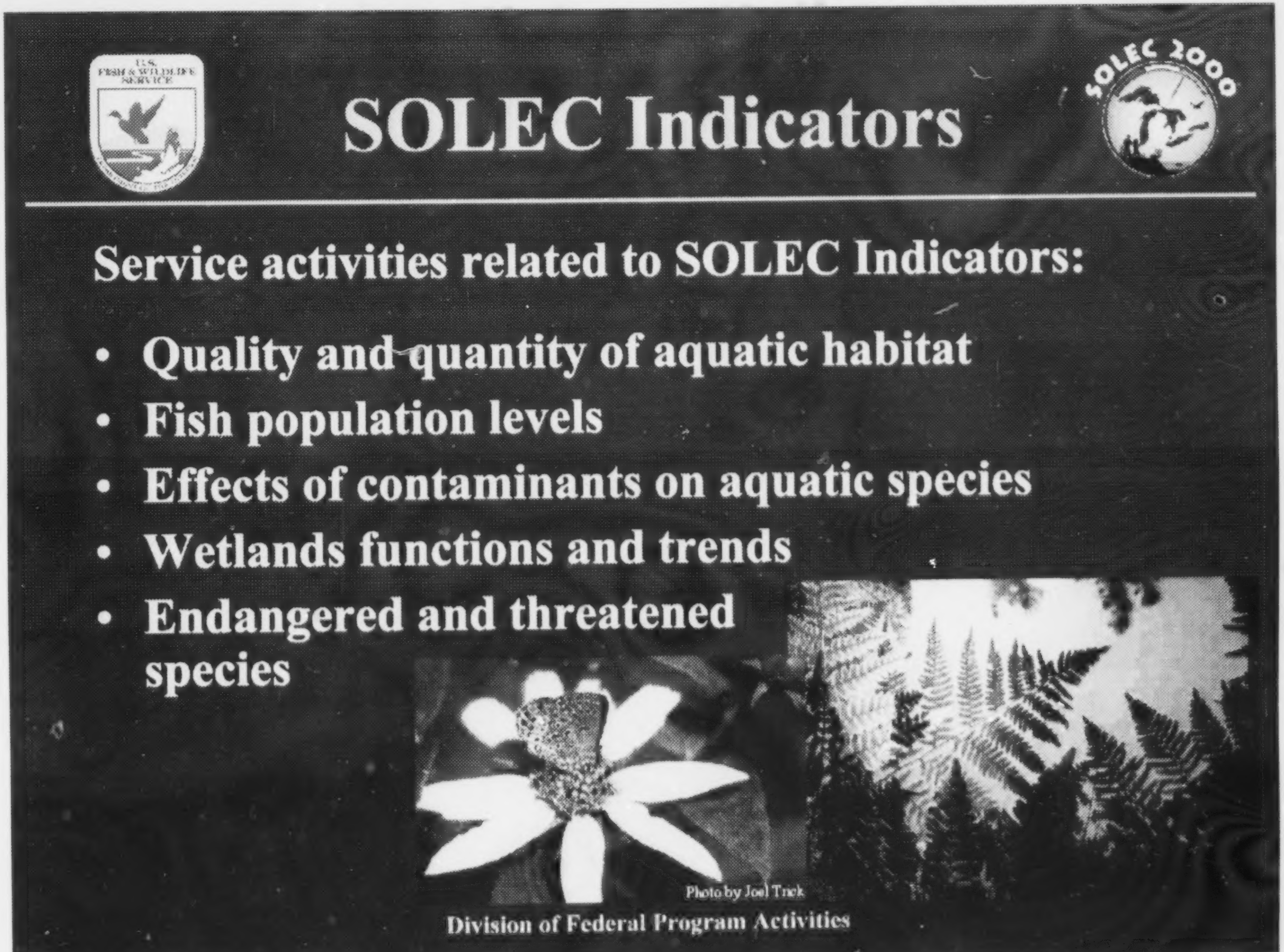
habitats for the continuing benefit of the American people."

Division of Federal Program Activities

SOLEC Indicators

- Provide an overview of environmental conditions in the Great Lakes
- Build upon the work of others
- Reflect broad spatial scales

Division of Federal Program Activities



SOLEC Indicators

Service activities related to SOLEC Indicators:

- Quality and quantity of aquatic habitat
- Fish population levels
- Effects of contaminants on aquatic species
- Wetlands functions and trends
- Endangered and threatened species

Photo by Joel Trick

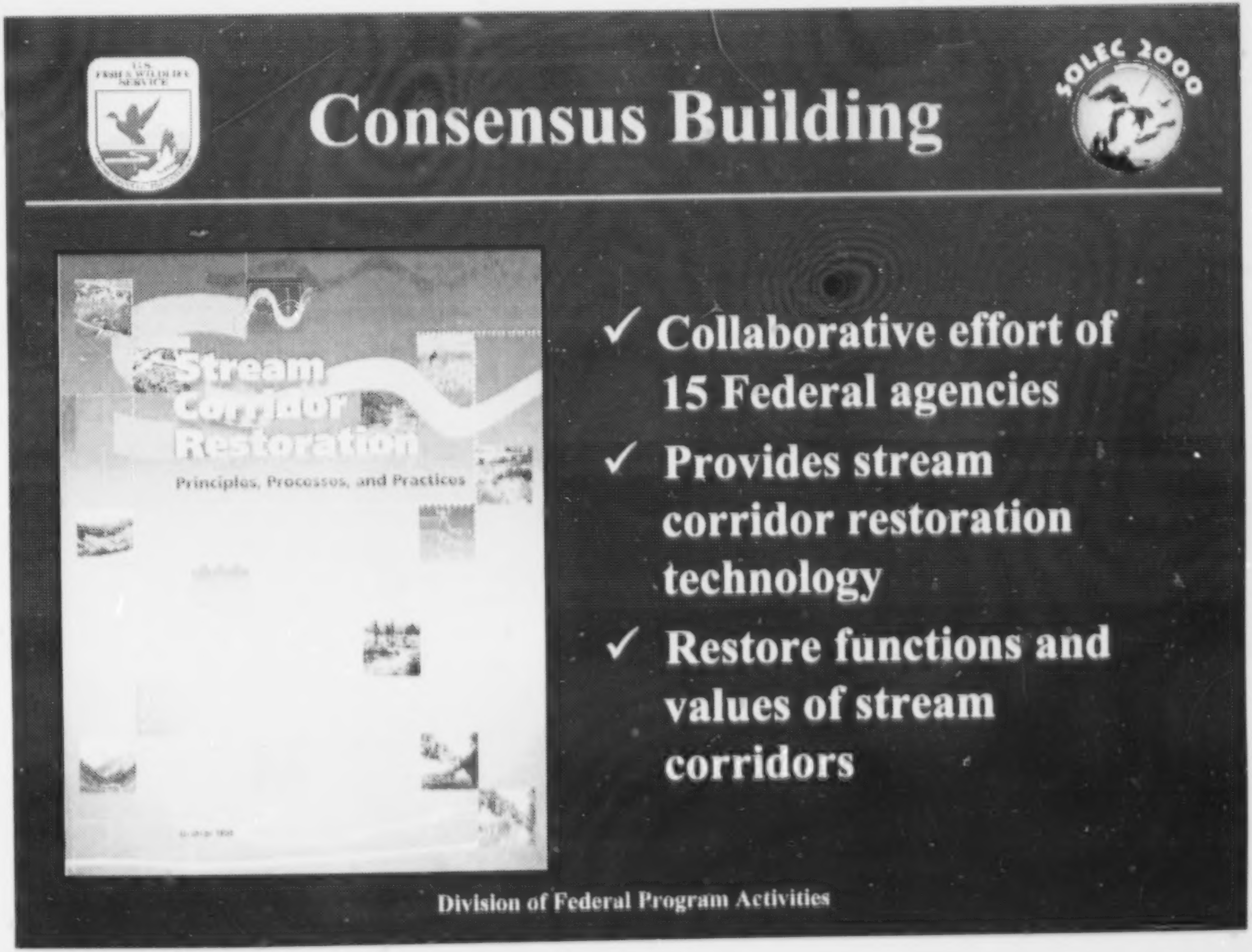
Division of Federal Program Activities

SOLEC 2000
U.S. FISH & WILDLIFE SERVICE

SOLEC Indicators

SOLEC Indicators stress three key elements of resource protection and habitat conservation:

- Consensus Building
- Ecosystem Approach
- Partnerships



Consensus Building

Stream Corridor Restoration

Principles, Processes, and Practices

- ✓ Collaborative effort of 15 Federal agencies
- ✓ Provides stream corridor restoration technology
- ✓ Restore functions and values of stream corridors

Division of Federal Program Activities

FWS Ecosystem Approach

Ecosystems include:

- living organisms
- physical surroundings
- natural cycles

Why work on Ecosystems?

- Comprehensive
- health of all biota
- Watershed-based

Division of Federal Program Activities

U.S. Fish & Wildlife Service

FWS Ecosystem Approach

SOLEC 2000

North American

Land Acquisition

Refuges

Coastal

Fishery Resources

Law Enforcement

Partners for Fish and Wildlife

Ecological Services

Hatcheries

Endangered Species

All Service's field units in a watershed combine forces to tackle projects, improving efficiency and effectiveness

Division of Federal Program Activities

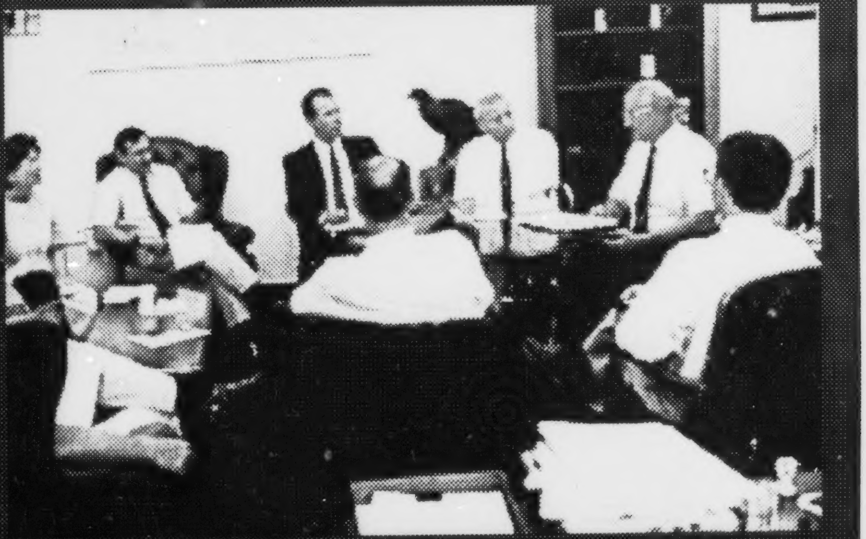
FWS Ecosystem Approach

A Major Key to Success is

PARTNERSHIPS

Division of Federal Program Activities

FWS Ecosystem Approach

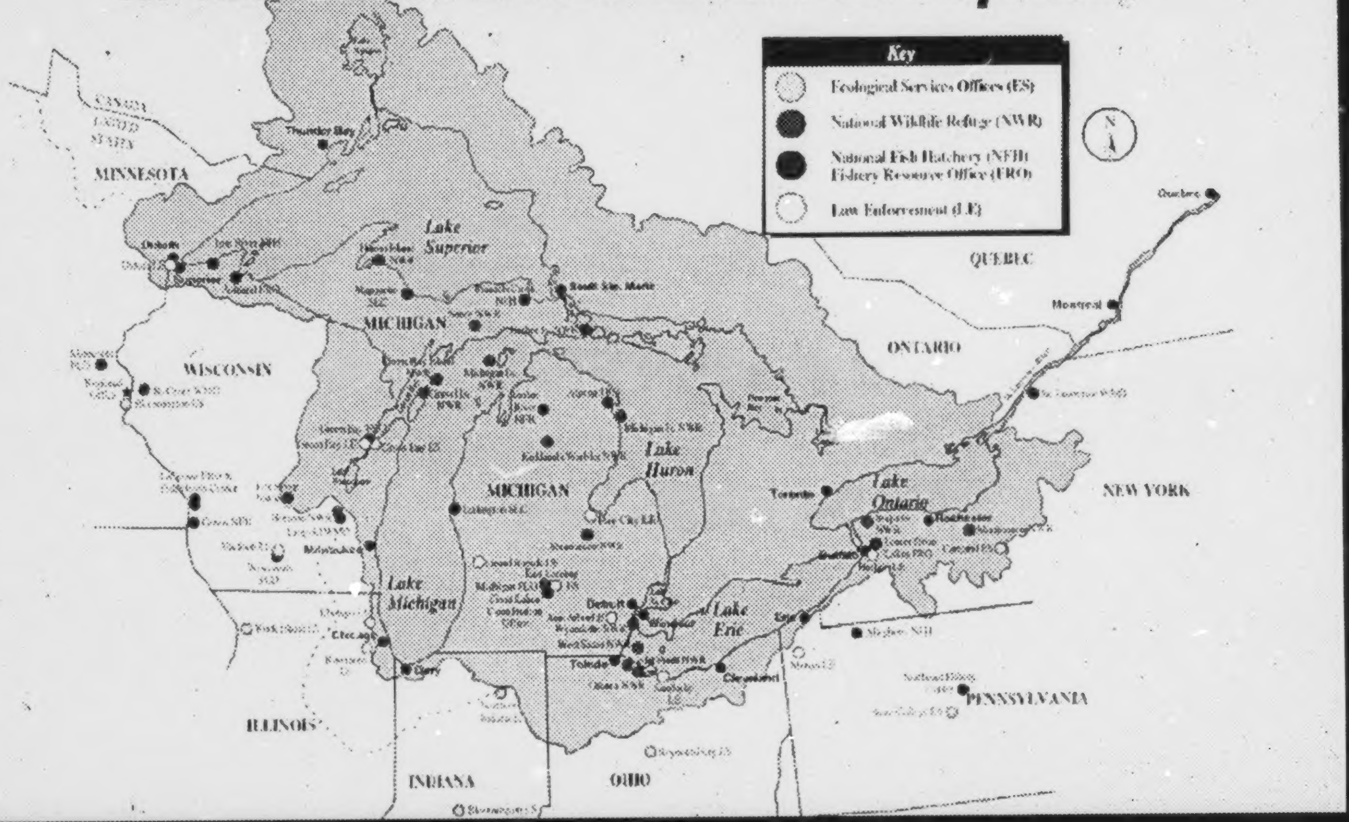


Partners

- ✓ Federal agencies
- ✓ International partners
- ✓ State, county, & city agencies
- ✓ Tribes/First Nations
- ✓ Conservation organizations
- ✓ Industry
- ✓ Local organizations and stakeholders

Great Lakes Basin Ecosystem Team

U.S. Fish & Wildlife Service in the Great Lakes Basin Ecosystem


Key
○ Ecological Services Offices (ES)
● National Wildlife Refuge (NWR)
● National Fish Hatchery (NFH) Fishery Resource Office (FRO)
○ Law Enforcement (LE)
N
CANADA
UNITED STATES
MINNESOTA
WISCONSIN
MICHIGAN
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
NEW YORK
ONTARIO
QUEBEC
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
Thunder Bay
Duluth
Sault Ste. Marie
Montreal
Quebec
Toronto
Detroit
Toledo
Cleveland
Erie
Buffalo
Rochester
Chicago
Gary
Milwaukee

Division of Federal Program Activities

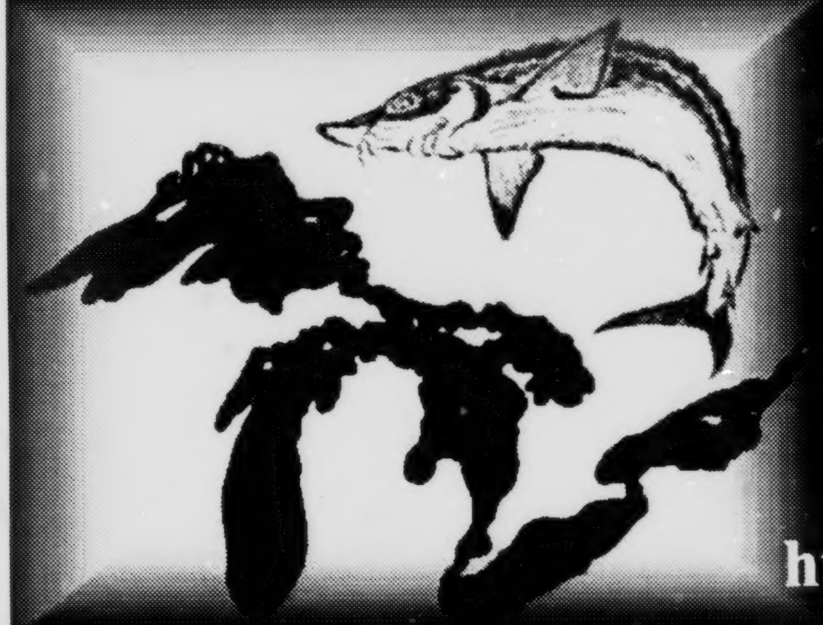
Great Lakes Basin Ecosystem Team

Fish and Wildlife Resource Issues Include:

- Lake sturgeon protection & restoration
- Fish passage
- Great Lakes islands
- Invasive species
- Colonial waterbird protection and recovery

Great Lakes Ecosystem Team
Lake Sturgeon

Fish Community Objective of the Lake Committees of each of the Great Lakes

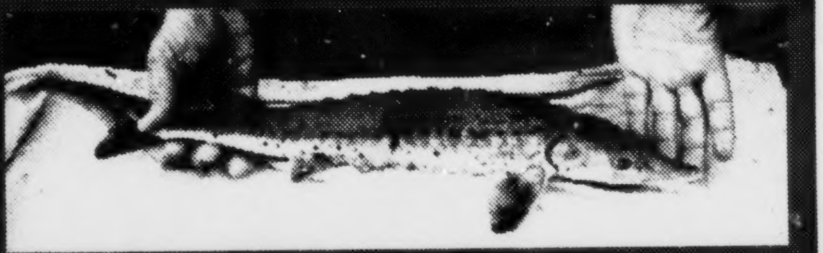


Great Lakes Ecosystem Team established a Lake Sturgeon Committee to work with internal and external partners

http://midwest.fws.gov/sturgeon/

Division of Federal Program Activities

Great Lakes Ecosystem Team
Lake Sturgeon



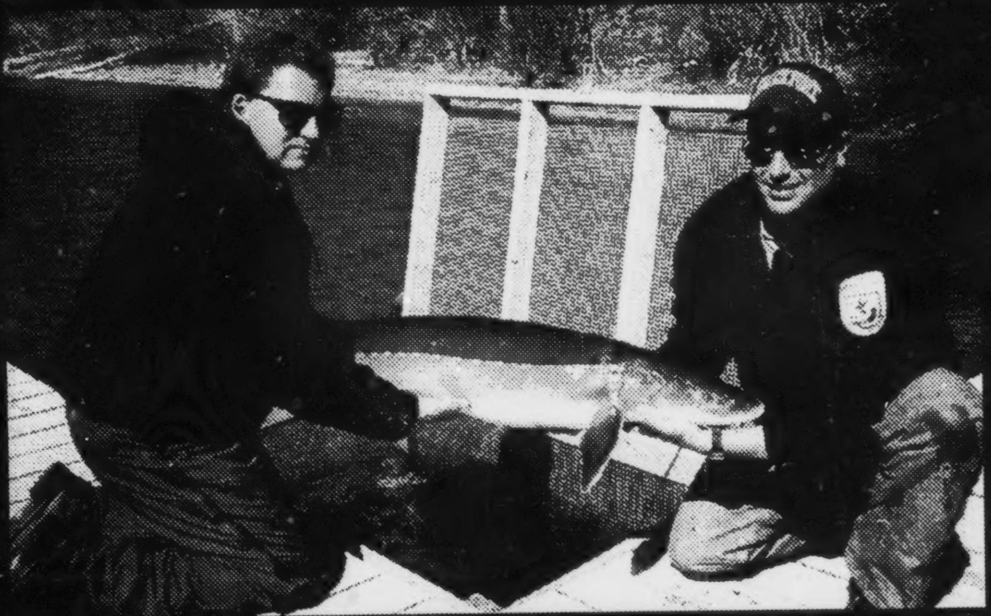
Restoration efforts:

- Population assessment
- Genetic make-up of various stocks
- Recovery plans
- Fish passage technology

Division of Federal Program Activities

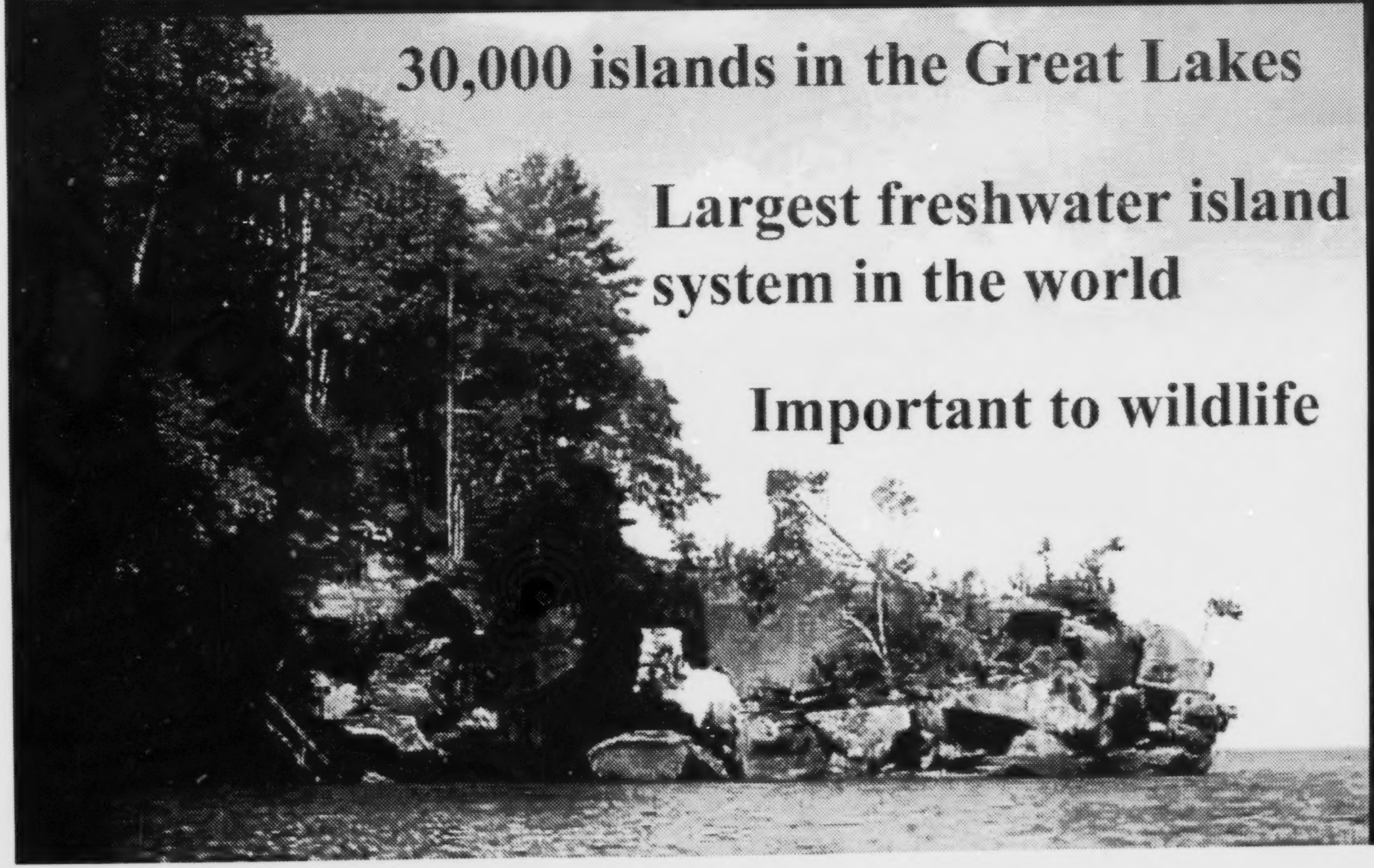
Great Lakes Ecosystem Team
Lake Sturgeon

Team needs include:



- Inventory of current status/historic habitat
- Reintroduction or expansion priorities
- Identification of impediments to reintroduction or expansion

Great Lakes Ecosystem Team
Great Lakes Islands

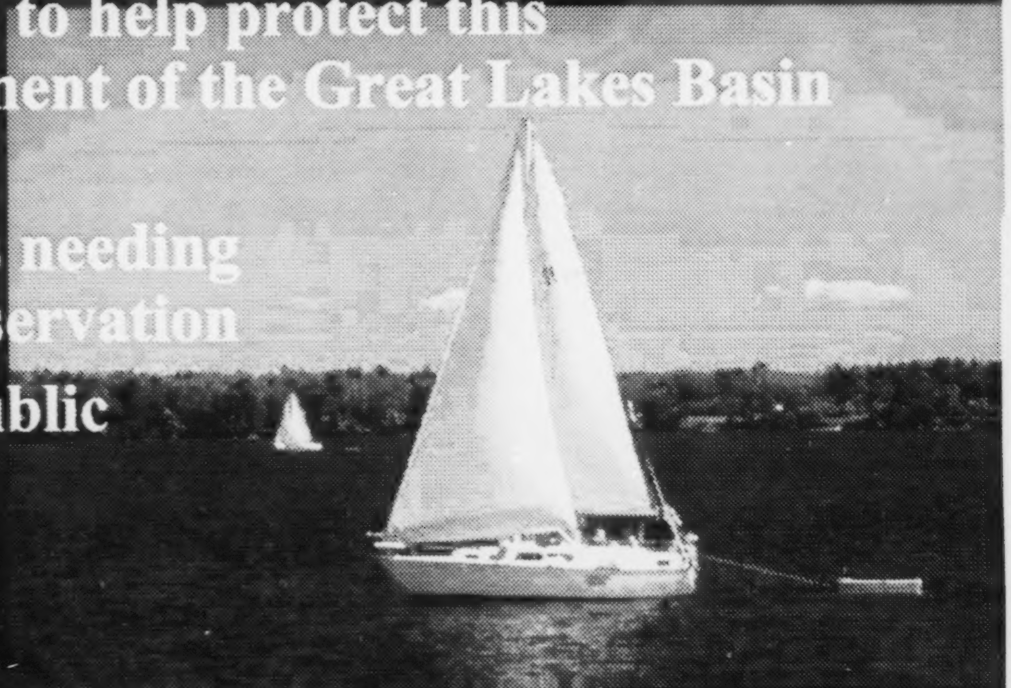


30,000 islands in the Great Lakes

Largest freshwater island system in the world

Important to wildlife

Great Lakes Ecosystem Team
Great Lakes Islands



- Need to develop an assessment of Great Lakes Islands
- Results to be used to help protect this important component of the Great Lakes Basin Ecosystem
- Determine islands needing protection or conservation
- Includes active public outreach effort

Division of Federal Program Activities

Great Lakes Basin Ecosystem Team

Additional Team Priorities:

- Migratory birds
- Double-crested cormorants
- Invasive species
- Outreach
- Geographic Information Systems/ Decision Support Systems

Division of Federal Program Activities

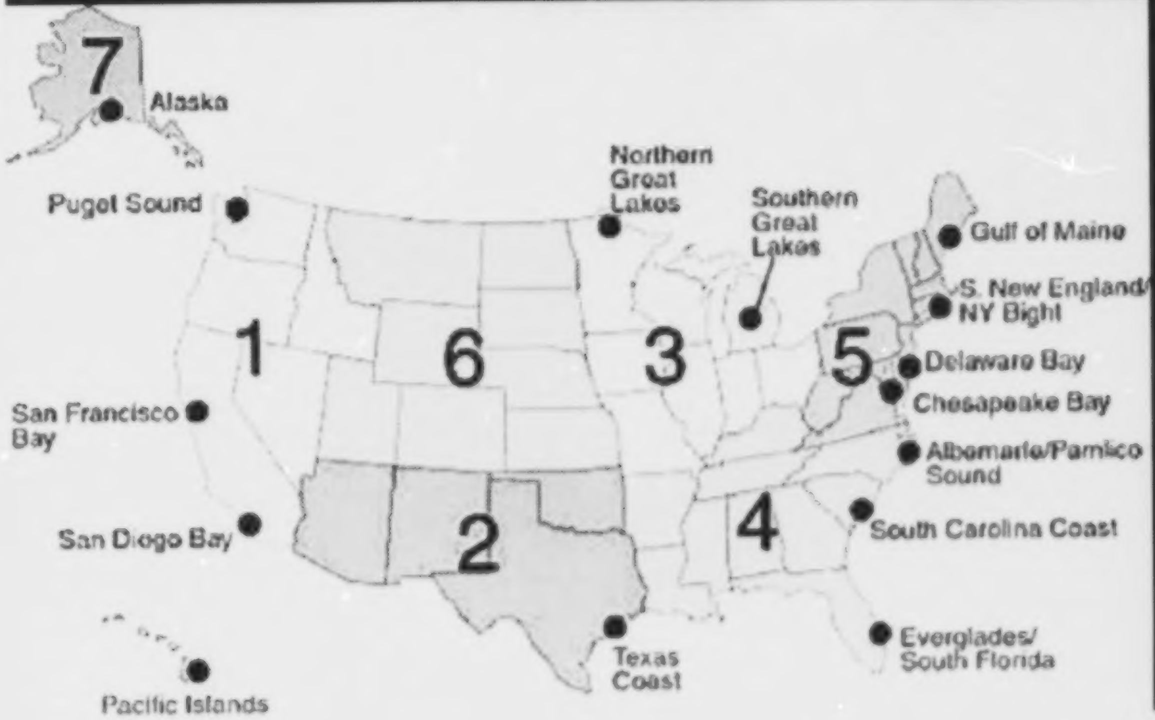
Great Lakes Basin Ecosystem Team

SOLEC Indicators Process

- Committee completed initial review
- Developing process to engage in SOLEC indicators process
- Approval and buy-in will be sought from Team and Regions 3 and 5 management

Coastal Program

- Focus on bays, estuaries, and watersheds
- Goal of conserving fish and wildlife and their habitats for healthy coastal ecosystems


7
Alaska
Puget Sound
Northern Great Lakes
Southern Great Lakes
Gulf of Maine
S. New England/ NY Bight
Delaware Bay
Chesapeake Bay
Albemarle/Pamlico Sound
South Carolina Coast
Everglades/ South Florida
Texas Coast
San Francisco Bay
San Diego Bay
Pacific Islands
1
6
3
5
2
4

- Funding of 15 priority ecosystems, including the Great Lakes

Coastal Program

- Maintain diversity, functions and productivity
- Promote natural self-sustaining populations

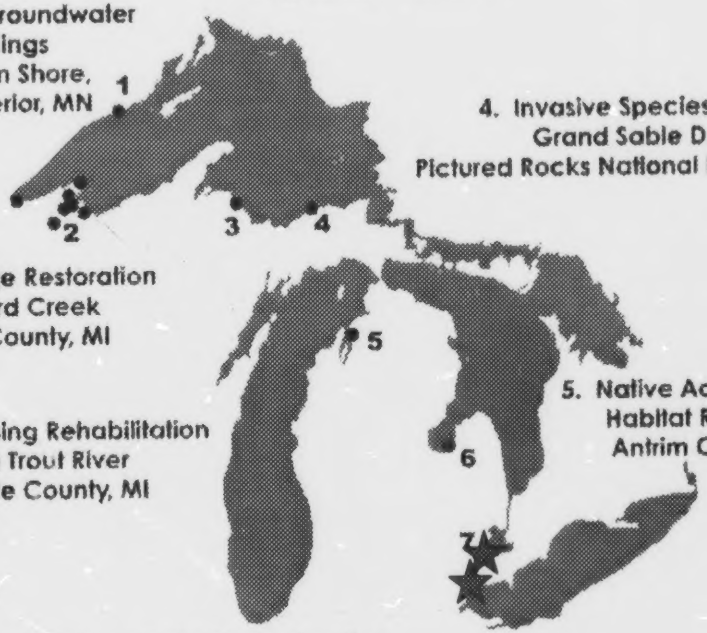
- Provide for ecologically sound public use, economic benefits and enjoyment

Division of Federal Program Activities

Coastal Program on the Great Lakes

SOLEC 2000

U.S. Fish & Wildlife Service Coastal Program Highlights
Region 3, FY2000



1. Mapping Groundwater Upwellings
Northern Shore,
Lake Superior, MN

2. Fish Passage Restoration
Graveyard Creek
Ashland County, MI

3. Road Crossing Rehabilitation
Salmon Trout River
Marquette County, MI

4. Invasive Species Control
Grand Sable Dune
Pictured Rocks National Lakeshore, MI

5. Native Aquatic Species
Habitat Restoration
Antrim County, MI

6. Lakeplain Prairie Restoration
and Monitoring
Tuscola County, MI

7. Belle Isle Restoration
Belle Isle, Detroit, MI

Division of Federal Program Activities

National Wetlands Inventory

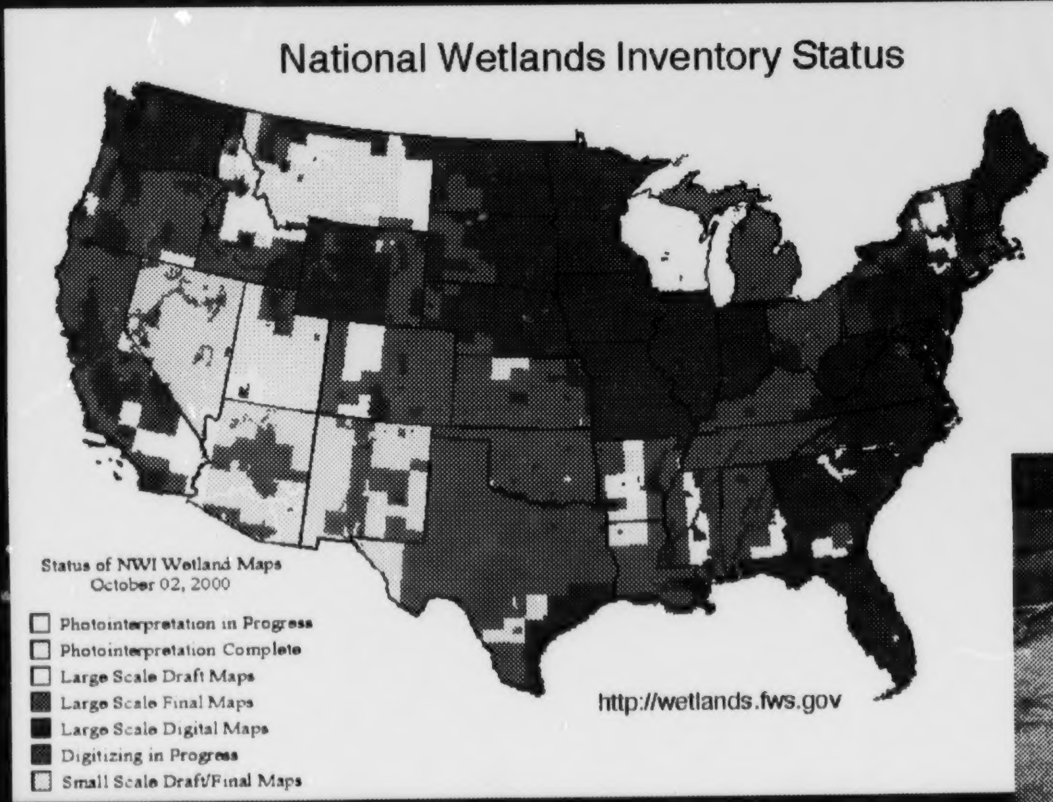
"Providing Wetland Information to the American People"

Generate information on the characteristics, extent and status of U.S wetlands and deepwater habitats

Adopted as Federal standard for classification, mapping and reporting

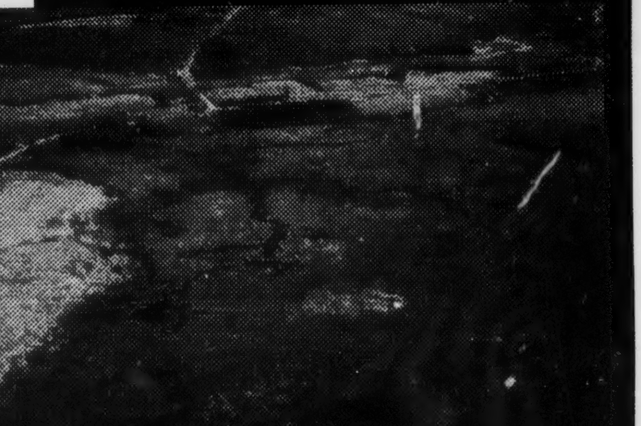
Division of Federal Program Activities

National Wetlands Inventory


National Wetlands Inventory Status

Status of NWI Wetland Maps
October 02, 2000
☐ Photointerpretation in Progress
☐ Photointerpretation Complete
☐ Large Scale Draft Maps
▨ Large Scale Final Maps
■ Large Scale Digital Maps
▨ Digitizing in Progress
☐ Small Scale Draft/Final Maps
http://wetlands.fws.gov

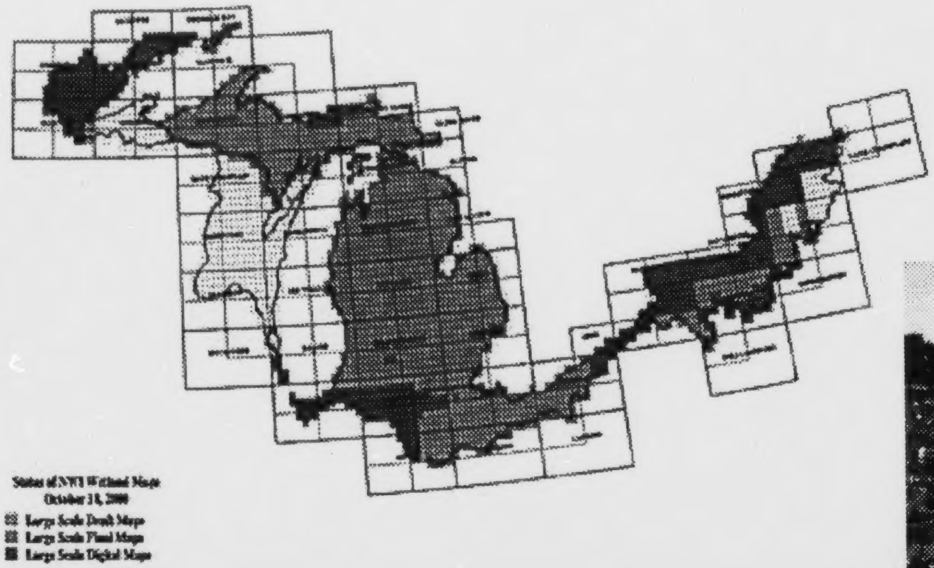
NWI has mapped 90% of the wetlands in the lower 48 States



Division of Federal Program Activities

National Wetlands Inventory

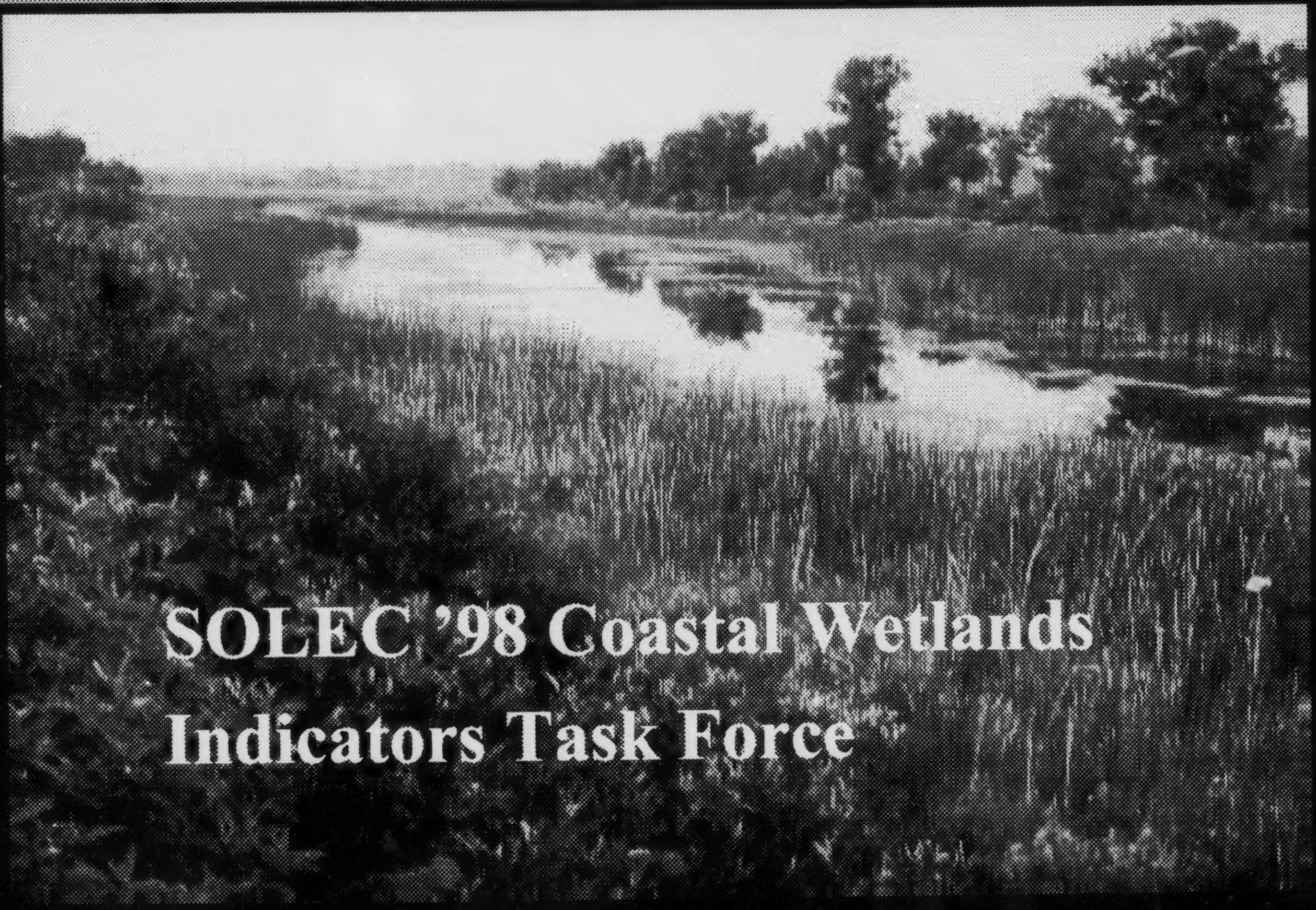
NATIONAL WETLANDS INVENTORY STATUS
Great Lakes Watershed


Status of NWI Wetland Maps
October 18, 2000
▨ Large Scale Draft Maps
▨ Large Scale Final Maps
■ Large Scale Digital Maps

NWI has mapped about 81% of the wetlands in the Great Lakes Watershed

Division of Federal Program Activities

Great Lakes Wetlands



SOLEC '98 Coastal Wetlands Indicators Task Force

Division of Federal Program Activities

Great Lakes Wetlands

- Wetland trend studies/ historical assessments
- Updated NWI large scale hard copy and digital maps

- Wetlands characterization
- Potential restoration sites
- Database for monitoring
- Coastal wetland buffer characterization

Division of Federal Program Activities

Great Lakes Wetlands

Great Lakes Wetlands Consortium

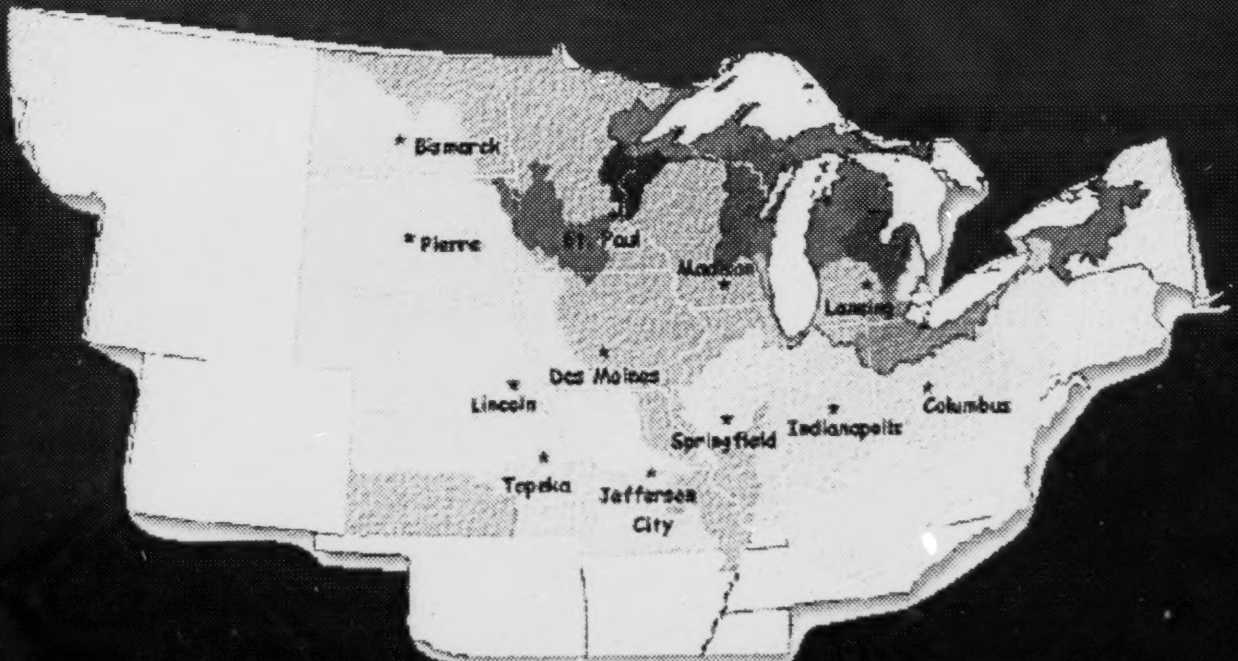
- Indicators of wetland condition
- Long-term monitoring program
- Binational database
- Multidisciplinary binational consortium to accomplish task
- FWS committed to be a partner

Midwest Natural Resources Group

- 14 federal agencies including the FWS
- Ongoing partnership focusing on natural resources and the environment
- To identify common issues and improve efficiency

Midwest Natural Resources Group

12 geographic "focus" areas in Great Lakes and Big Rivers basins


Bismarck
Pierre
St. Paul
Madison
Lansing
Des Moines
Lincoln
Springfield
Indianapolis
Columbus
Topeka
Jefferson City

Division of Federal Program Activities

Midwest Natural Resources Group

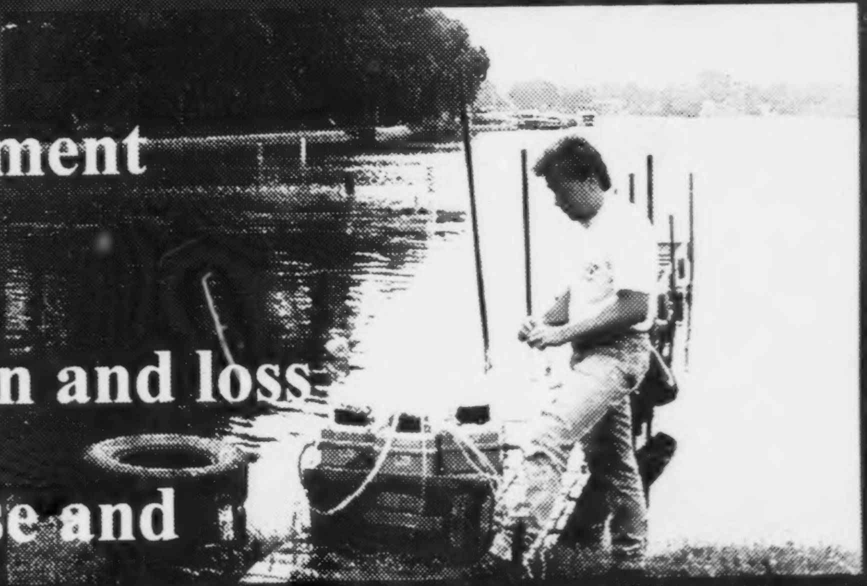
FWS is lead for four Focus Areas including two in the Great Lakes Basin:

Fox River/Green Bay, Wisconsin

Saginaw River and Bay, Michigan

Midwest Natural Resources Group

Team addressing:



- Non-point sources
- Contaminated sediment remediation
- Habitat degradation and loss
- Sustainable land use and development

City of Chicago Migratory Bird Treaty

- Urban Conservation Treaty for Migratory Birds Pilot Program
- Importance of migratory birds and urban areas
- FWS provides challenge funding & technical assistance
- City develops and implements bird conservation projects

City of Chicago
Migratory Bird Treaty

"The treaty is an important addition to our ongoing efforts through Nature Chicago to create open space, enhance habitat, and give Chicagoans the opportunity to appreciate and be stewards of the natural environment."

Richard M. Daley,
Mayor of Chicago

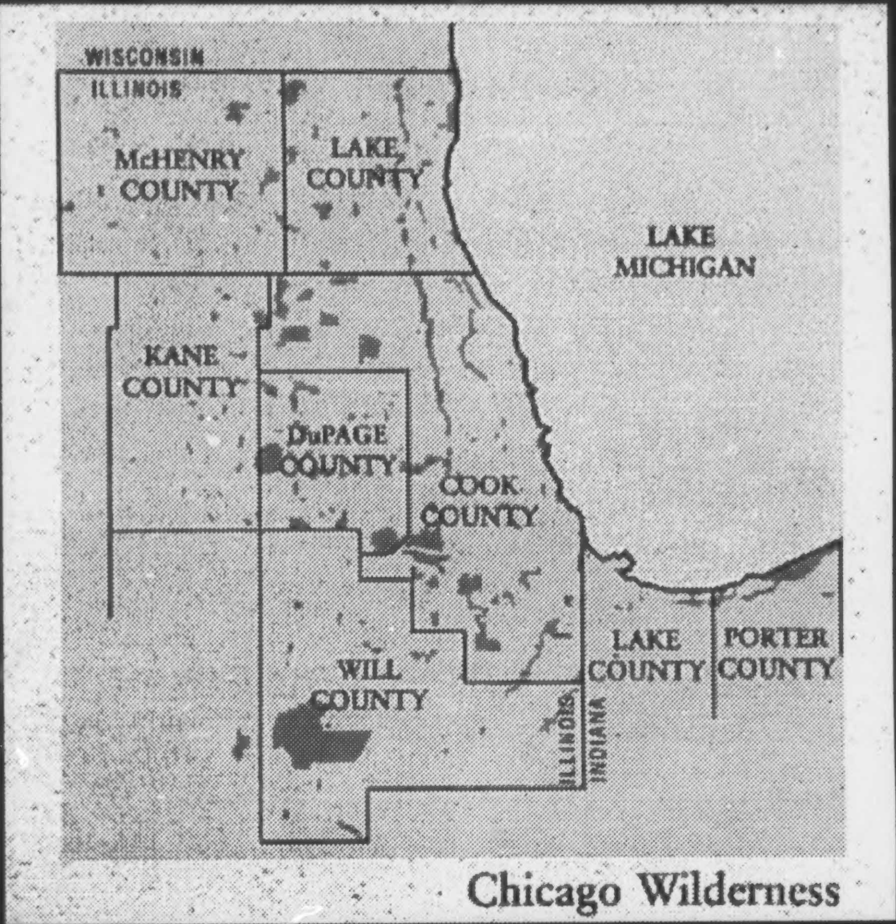
"Chicago has on outstanding record of building environmental partnerships with the Service. I'm proud that we can stand here today and cement our partnership in a way that will benefit not only birds, but also the quality of life of Chicago-area citizens."

Jamie Rappaport Clark,
Director, Fish and Wildlife Service

Division of Federal Program Activities

Chicago Wilderness

- Started in 1996
- Partnership of over 100 public and private organizations
- Protect, restore and manage protected natural areas
- Over 150 collaborative projects


WISCONSIN
ILLINOIS
McHENRY COUNTY
LAKE COUNTY
LAKE MICHIGAN
KANE COUNTY
DuPAGE COUNTY
COOK COUNTY
WILL COUNTY
ILLINOIS
INDIANA
LAKE COUNTY
PORTER COUNTY

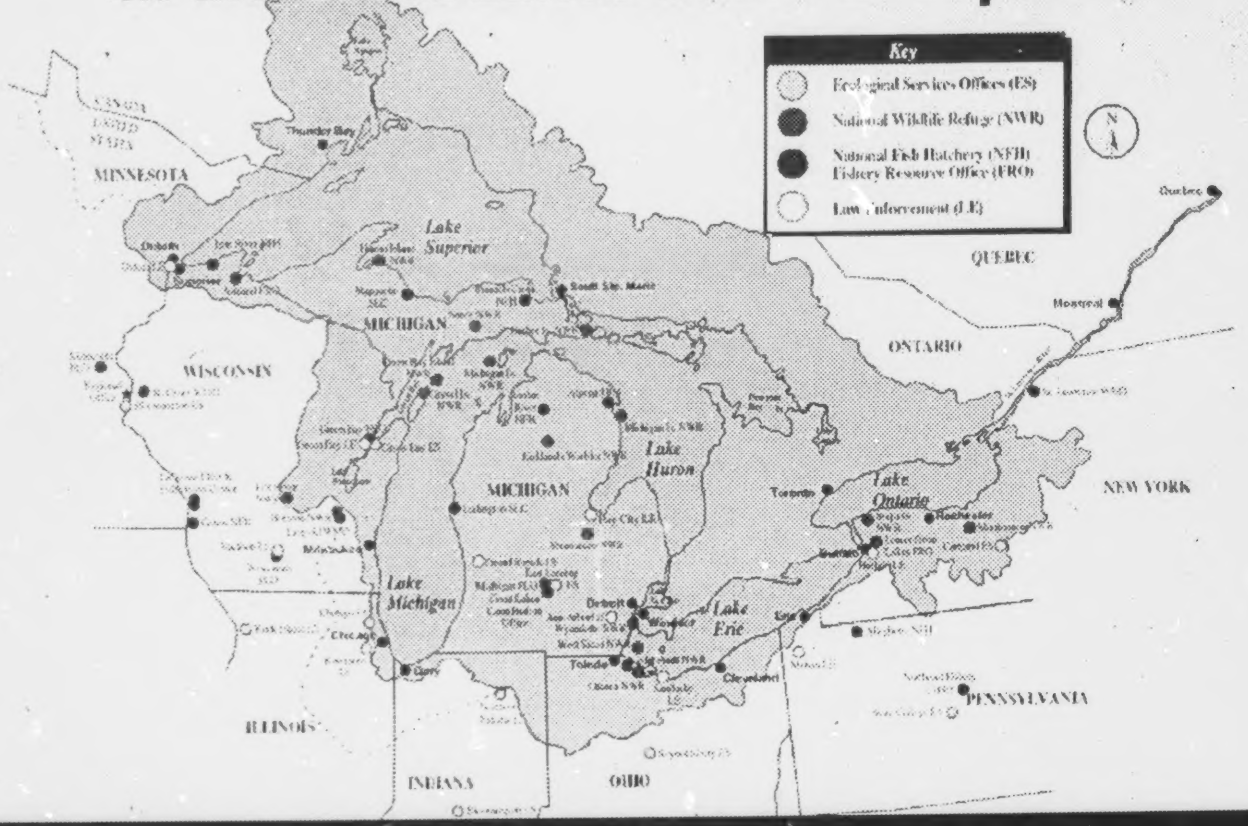
Chicago Wilderness

Division of Federal Program Activities

Other Service Programs

SOLEC 2000

U.S. Fish & Wildlife Service in the Great Lakes Basin Ecosystem


Key
Ecological Services Offices (ES)
National Wildlife Refuge (NWR)
National Fish Hatchery (NFH)
Fishery Resource Office (FRO)
Law Enforcement (LE)
N
CANADA
UNITED STATES
MINNESOTA
WISCONSIN
MICHIGAN
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
NEW YORK
ONTARIO
QUEBEC
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
Thunder Bay
Duluth
Sault Ste. Marie
Toronto
Montreal
Quebec
Chicago
Gary
Detroit
Toledo
Cleveland
Erie
Rochester
Milwaukee
Green Bay

Division of Federal Program Activities

In The New Millennium

- Strengthening the Ecosystem Approach to Fish and Wildlife Conservation
- Lifting the Conservation of Migratory Birds to a Higher Level
- Leading Efforts to Prevent the Introduction and Spread of Invasive Species

Division of Federal Program Activities

U.S. FISH & WILDLIFE SERVICE

In The New Millennium

SOLEC 2000

The Future of Success in Protecting and Conserving Fish and Wildlife Resources Depends on Effective Partnerships

Division of Federal Program Activities

SOLEC 2000 Day 3

Day1 | Day 2 | Day 3

Biodiversity and Non-Native Species Introductions in the St. Lawrence River
Yves de Lafontaine
Environment Canada
23 pages 572Kb

The State of Lake Ontario Lake Trout Rehabilitation
25 pages 2.6Mb

Lake Erie
A Changing Ecosystem
Sandra George
Environment Canada
22 pages 3.0Mb

St. Clair River-Lake St. Clair-Detroit River Corridor
Gary Johnson
Ontario Ministry of the Environment
25 pages 16Mb

Lake Huron: The Lake in the Middle
Larry Schleen
Fisheries and Oceans Canada
Jim Bredin
Michigan Office of the Great Lakes
43 pages 2.7Mb

Lake Michigan: Lake USA
Judy Beck
United States
Environmental Protection Agency
32 pages 1.9Mb

Lake Superior Basin Ecosystem
Darrell Piekarz
Environment Canada
35 pages 2.9Mb

State of the Lake Michigan Fisheries
Thomas Trudeau
Illinois Department of Natural Resources
21 pages 938Kb

Day1 | Day 2 | Day 3

Biodiversity and Non-Native Species Introductions in the St. Lawrence River

Yves de Lafontaine
St. Lawrence Centre, Environment Canada
Montréal, Québec

The Biodiversity Portrait of the St. Lawrence

- A New Tool available on the Web
- http://www.qc.ec.gc.ca/faune/biodiv/

- A synthesis of information & a georeferenced database
  - 28 000 sites
  - 465 000 entries
  - 5 000 species

- To aid developing a conservation strategy of the St. Lawrence River ecosystem

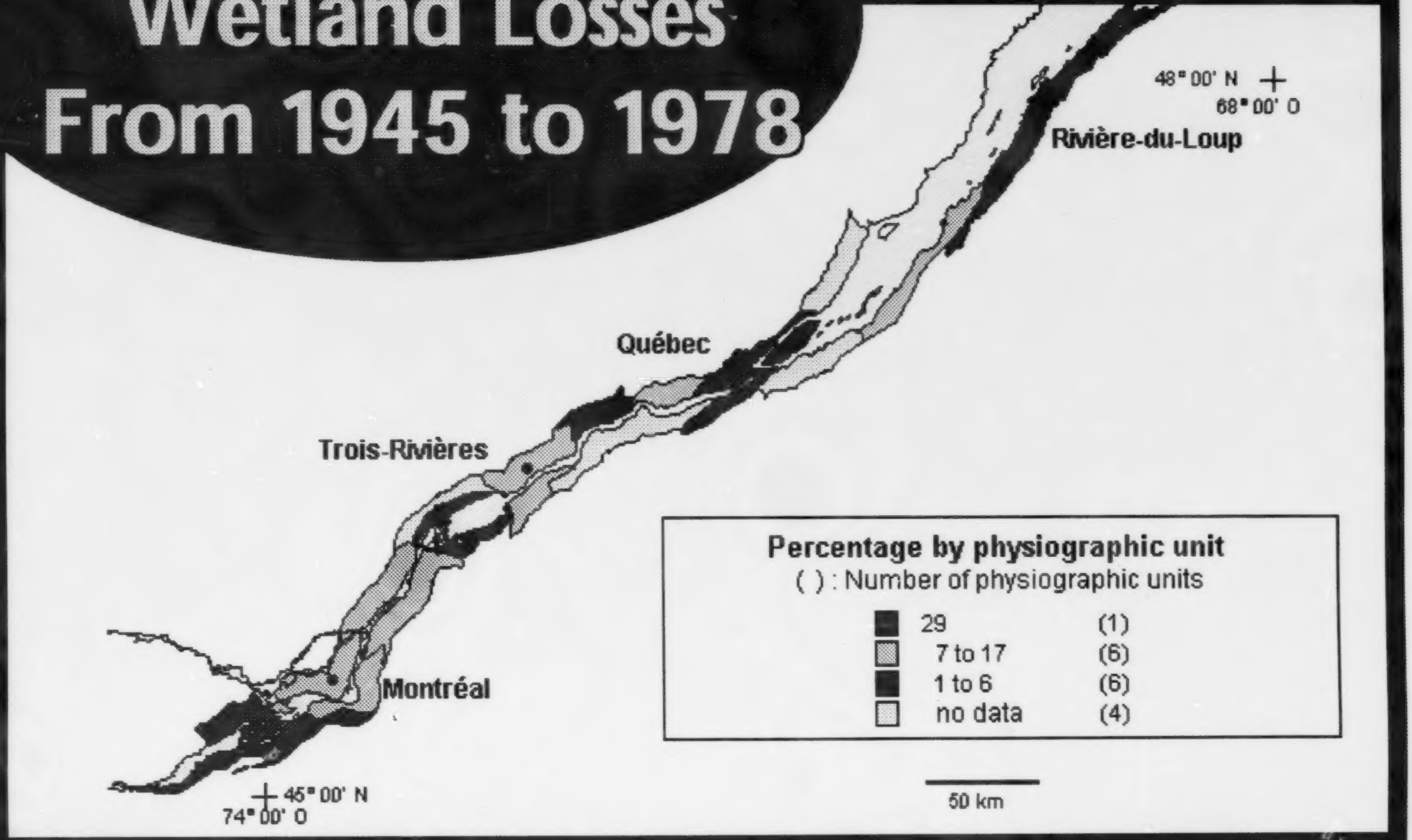
Habitat Losses Along the St. Lawrence River

- ~50% of shoreline modified by agriculture and urbanization
- 25% of shoreline subjected to erosion
  - 1 500 ha of island habitats lost since 1950 !
- Possible scenario :
  - Decline in river flow : 40% of wetlands lost over the next 50 yrs !
  - 4 000 ha of island habitats under stress !

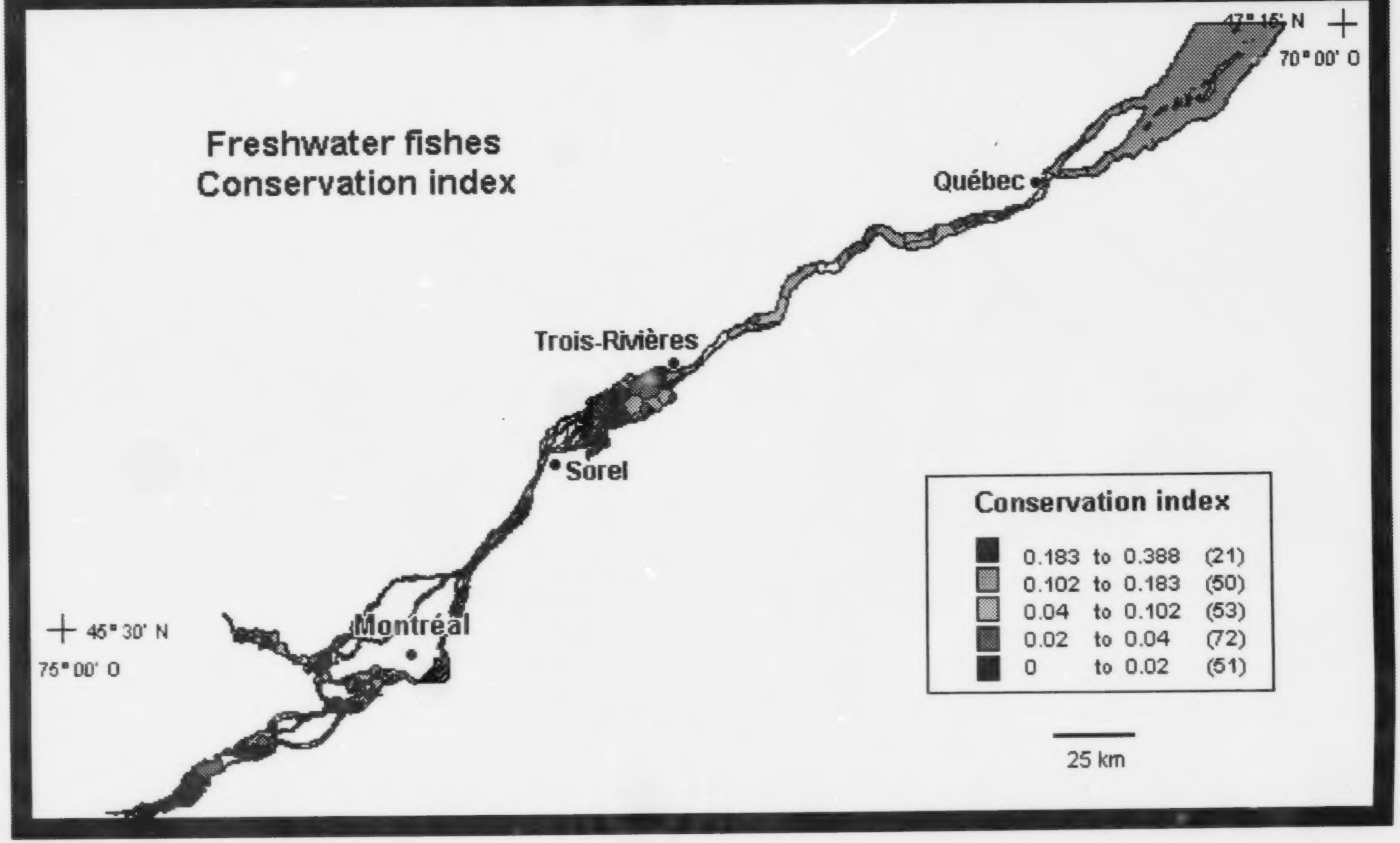
Wetland Distribution Along the St. Lawrence River

	Total Wetlands (ha)	Submerged Vegetation	Marsh	Wet Meadow	Swamp
Fresh water	63000	30260	12600	7540	12600
Fluvial estuary	11940	-	7630	4070	240
Marine sector	4760	?	950	3810	-
Total	79700	38 %	27 %	19 %	16 %

Percentage of Wetland Losses From 1945 to 1978

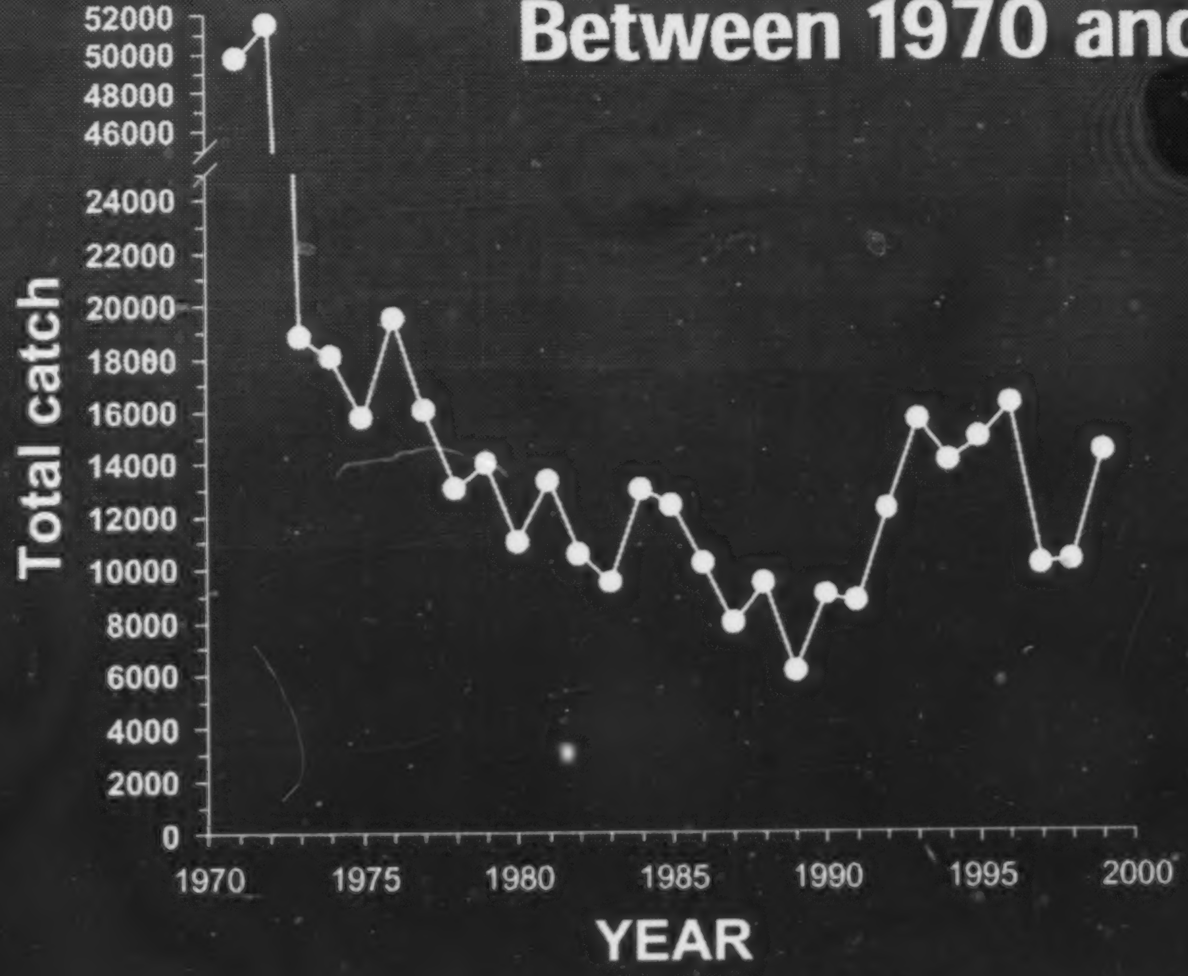

48° 00' N
68° 00' O
Rivière-du-Loup
Québec
Trois-Rivières
Montréal
45° 00' N
74° 00' O
Percentage by physiographic unit
( ) : Number of physiographic units
29 (1)
7 to 17 (6)
1 to 6 (6)
no data (4)
50 km

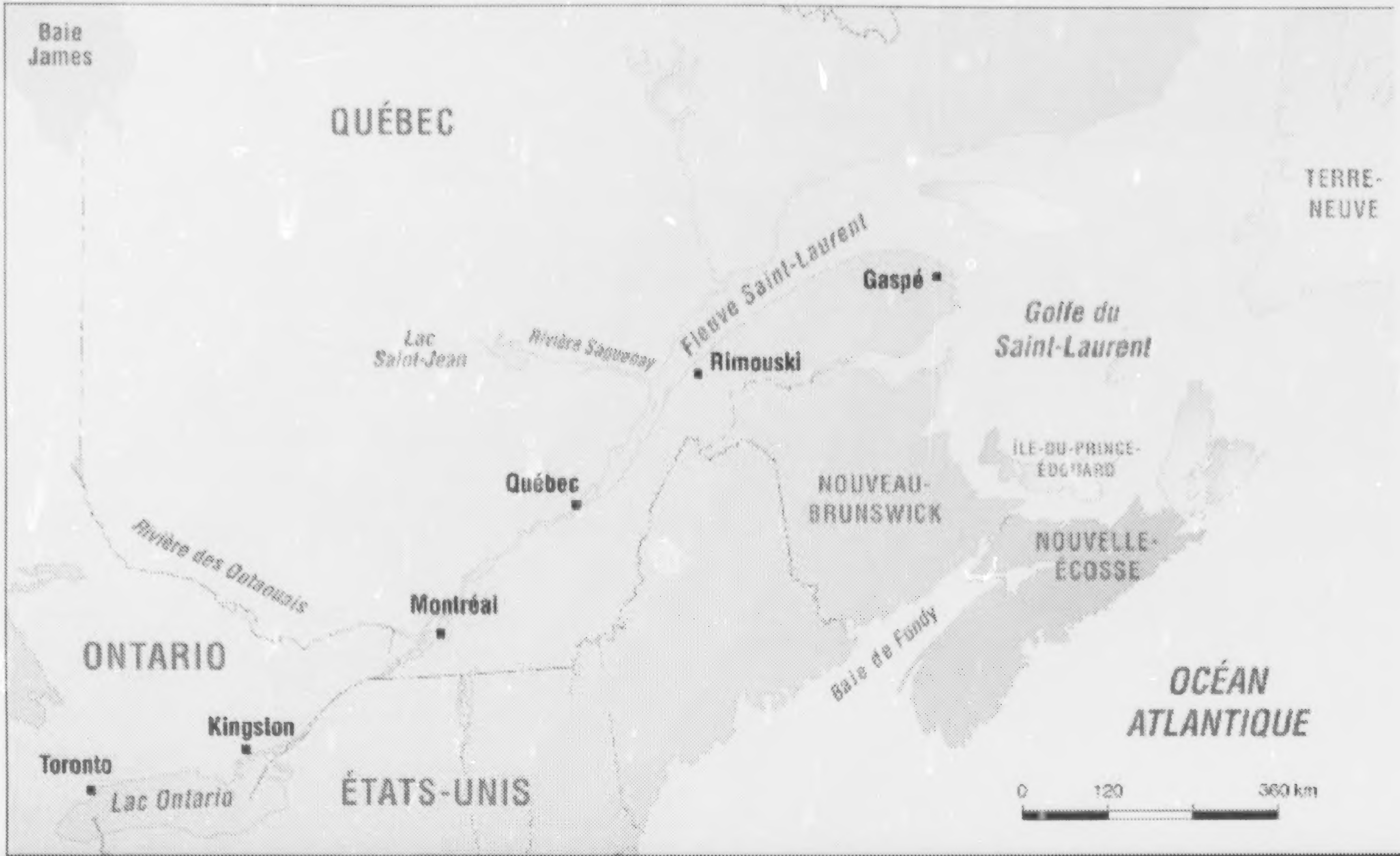
Freshwater Fish Biodiversity in the St. Lawrence River


Freshwater fishes
Conservation index
47° 15' N
70° 00' O
Québec
Trois-Rivières
Sorel
Montréal
45° 30' N
75° 00' O
Conservation index
0.183 to 0.388 (21)
0.102 to 0.183 (50)
0.04 to 0.102 (53)
0.02 to 0.04 (72)
0 to 0.02 (51)
25 km

Impact on the St. Lawrence [illegible]water fish community ?

Freshwater Fish Decline at the St-Nicolas Experimental Fishery Between 1970 and 1999




Baie James
QUÉBEC
TERRE-NEUVE
Fleuve Saint-Laurent
Gaspé
Golfe du Saint-Laurent
Lac Saint-Jean
Rivière Saguenay
Rimouski
ÎLE-DU-PRINCE-ÉDOUARD
Québec
NOUVEAU-BRUNSWICK
NOUVELLE-ÉCOSSE
Rivière des Outaouais
Montréal
ONTARIO
Baie de Fundy
OCÉAN ATLANTIQUE
Kingston
Toronto
Lac Ontario
ÉTATS-UNIS
0
120
360 km

Species introductions in the St. Lawrence River

Foreign Shipping (1978-1996)

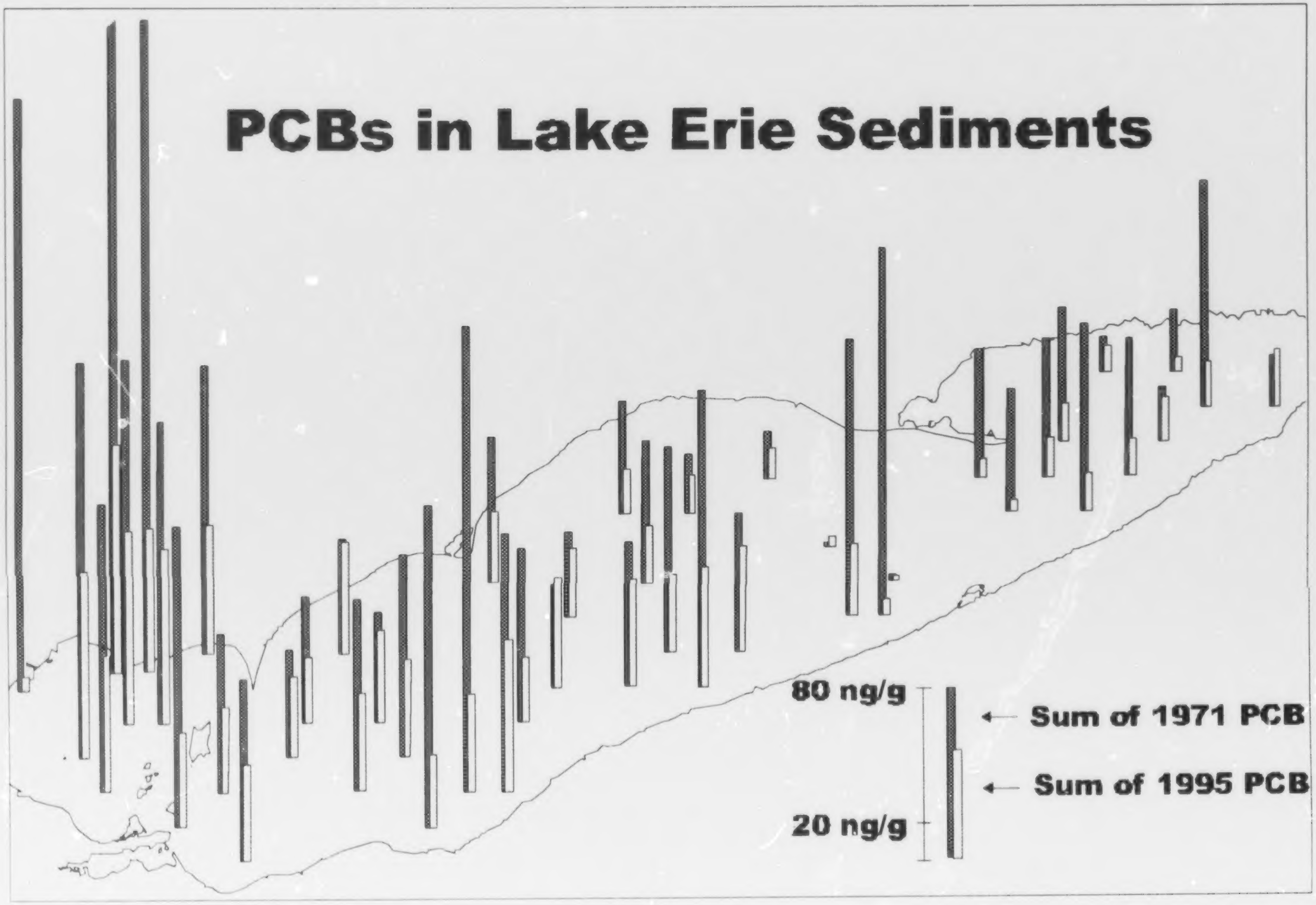
	Ship arrivals		Ballast capacity	
Destination	(No. yr^{-1})	%	(10^6 MT yr^{-1})	%
Great Lakes	249 ±39	19	2.3 ±0.5	17.5
St. Lawrence River	1048 ±104	81	10.8 ±2.3	82.5
Montreal	*735*	*70*	*6*	*60*
Quebec	*179*	*17*	*3*	*27*
Other harbours	*135*	*13*	*1.8*	*13*

from Bourgeois, Gilbert & Cusson 2000

Objectives

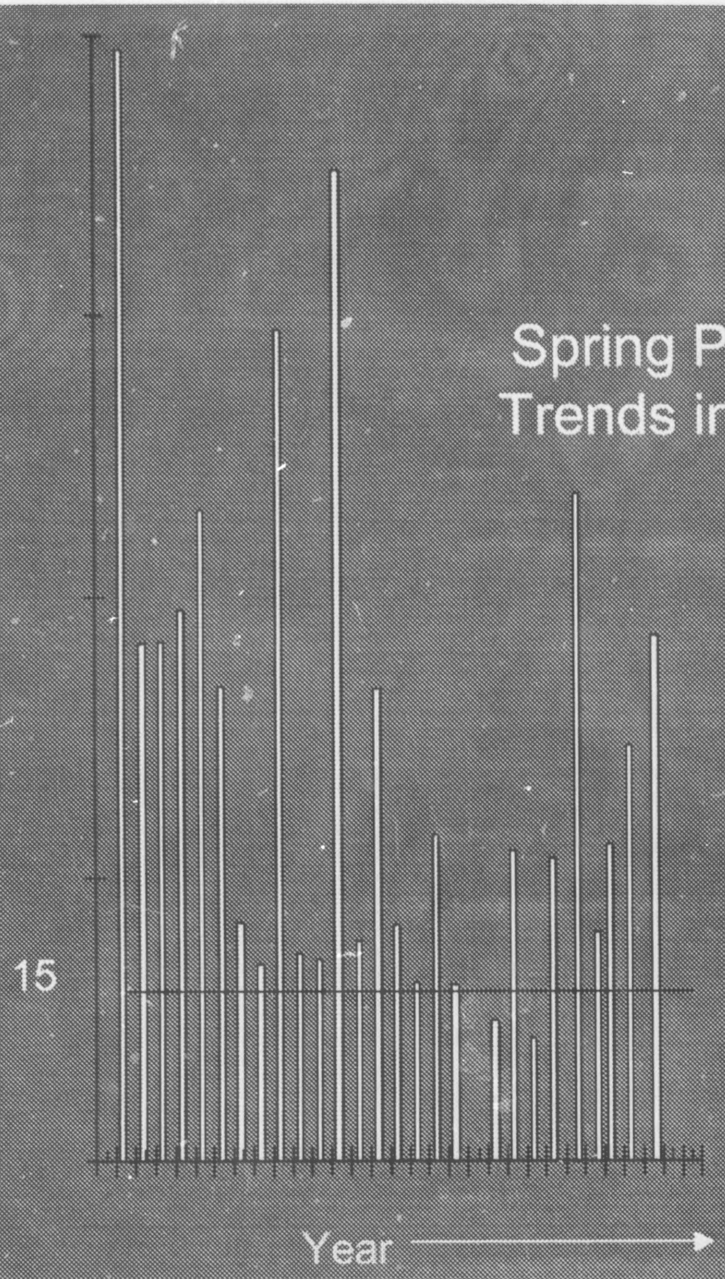
- List of species introduced in the St. Lawrence River
- Evaluate the transfer of species between the Great Lakes and the river
- Assess the spatial distribution and temporal trend of introduced species

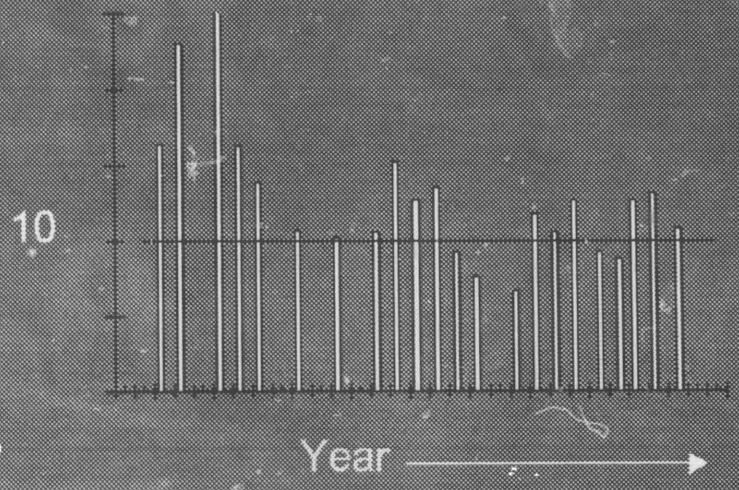
PCBs in Lake Erie Sediments

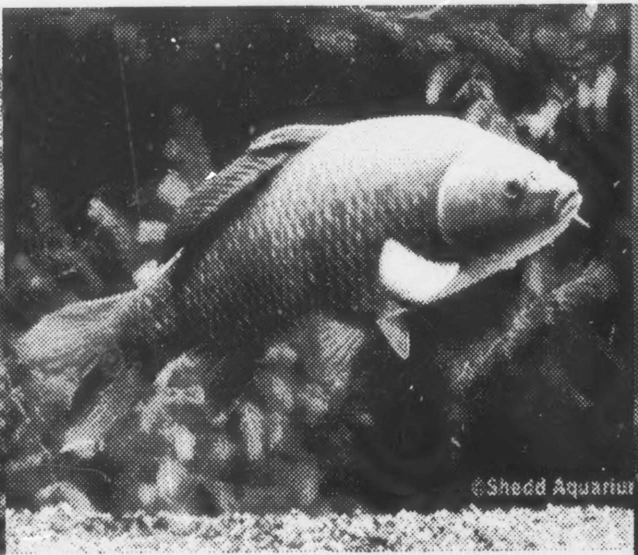

80 ng/g
20 ng/g
← Sum of 1971 PCB
← Sum of 1995 PCB

Nutrients

Spring Phosphorus Concentration (ug/g)
Trends in Western and Eastern Lake Erie
1970-to 2000

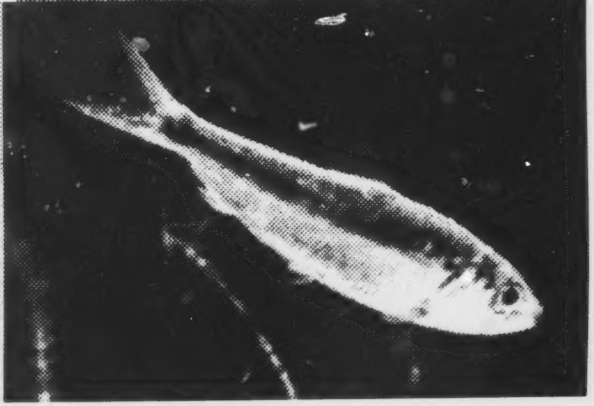





©Shedd Aquariu

Non-Native Species

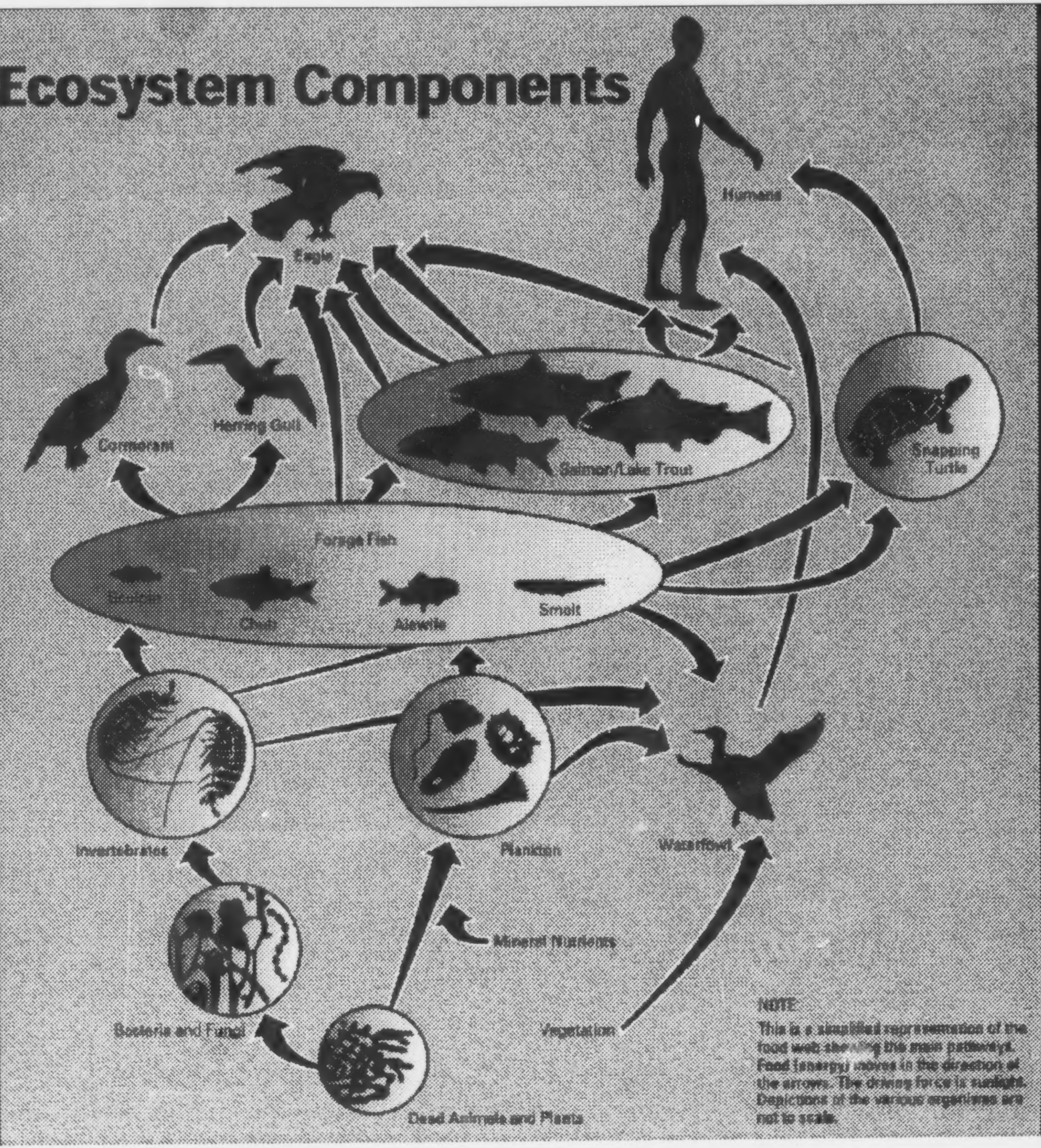
Coming soon!!



Habitats

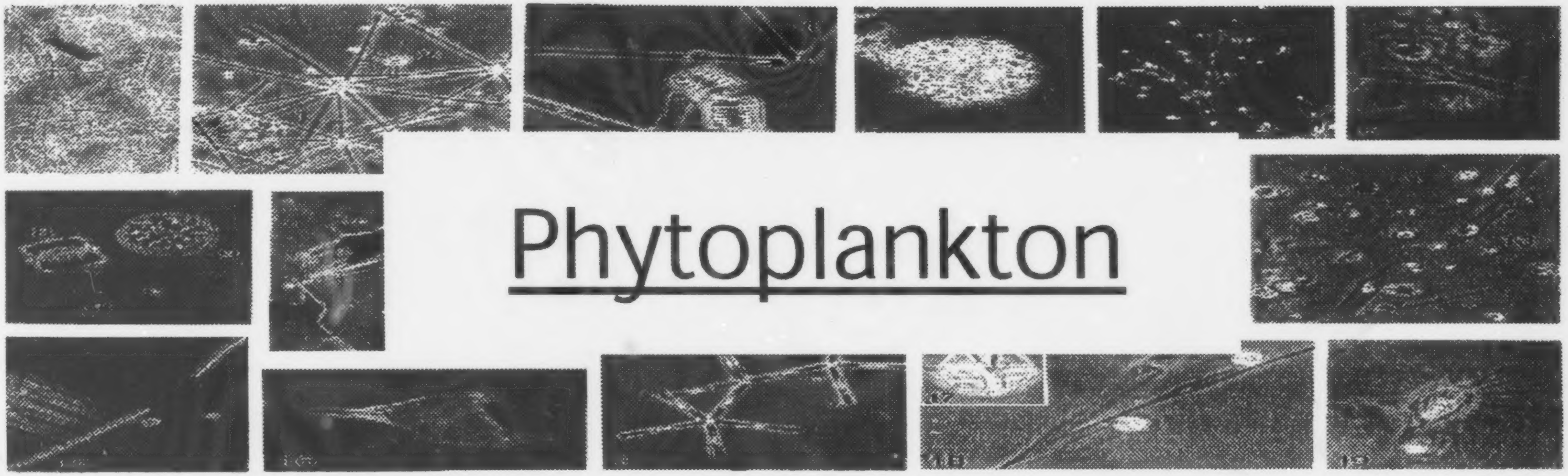
- Wetlands
- Forests
- Beaches
- Sand Dunes and Barrens
- Open Lake
- Tributaries
- Prairies

Ecosystem Components


Humans
Eagle
Cormorant
Herring Gull
Salmon/Lake Trout
Snapping Turtle
Forage Fish
Sculpin
Chub
Alewife
Smelt
Invertebrates
Plankton
Waterfowl
Mineral Nutrients
Bacteria and Fungi
Vegetation
Dead Animals and Plants

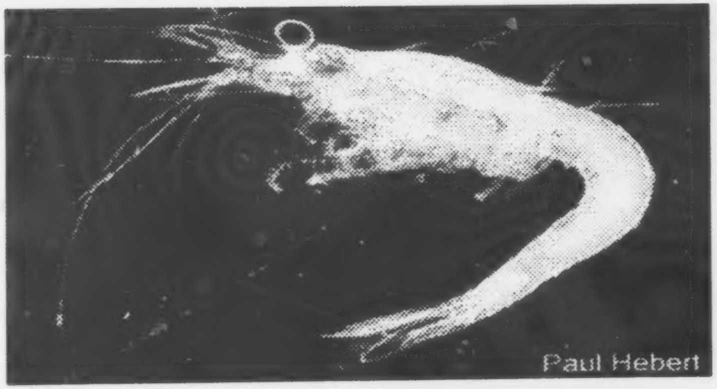
NOTE:
This is a simplified representation of the food web showing the main pathways. Food (energy) moves in the direction of the arrows. The driving force is sunlight. Depictions of the various organisms are not to scale.

Phytoplankton

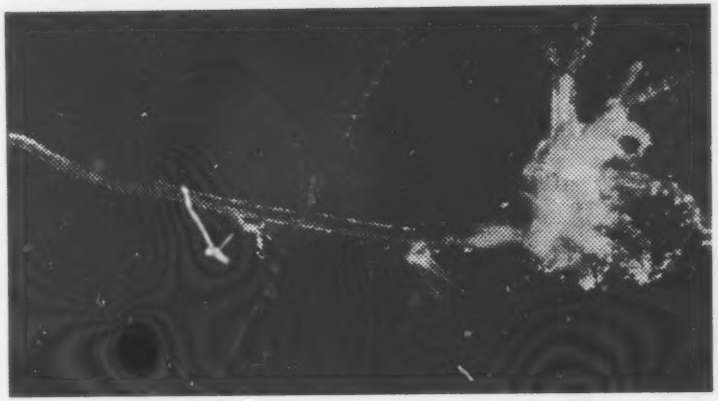


- Eutrophic conditions of the 1960's gone
- Significant changes in the 1990's likely due to zebra mussels
- Biomass in the east basin is less than predicted from phosphorus loadings
- Diatom biomass very low with some species lost
- *Microcystis* blooms in west basin
- Reduced energy input to phytoplankton is having an impact on higher levels in the pelagic foodweb

Zooplankton



Paul Hebert



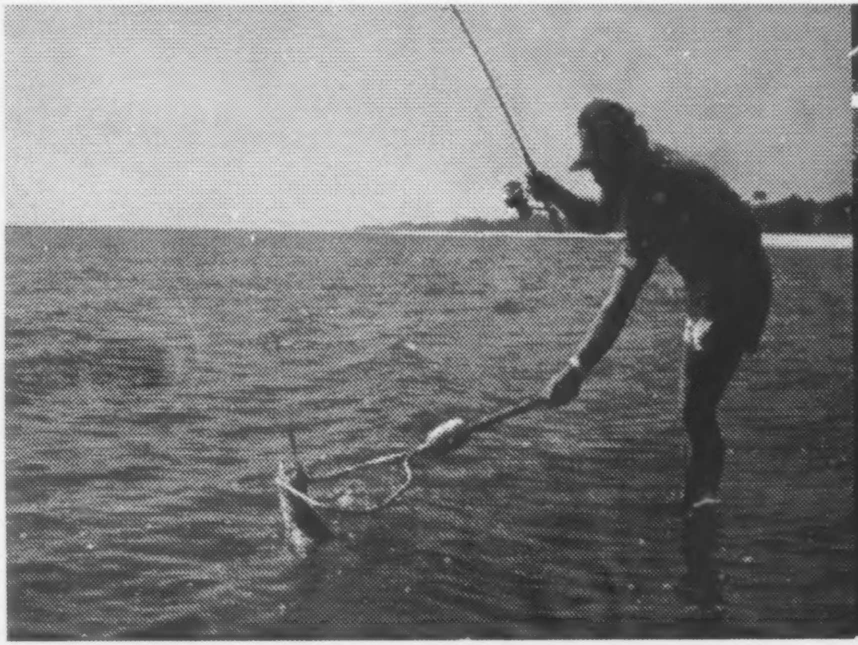
- Populations of large cold water species reduced
- Changes most profound in eastern Basin
- *Dreissena* veligers, *Bythotrephes*
- Dreissenids grazing appears to be altering community structure
- Mean size of individual <.8mm

Benthos

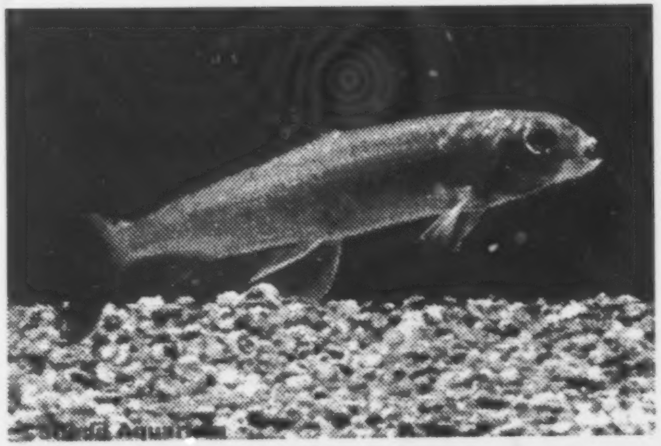
Hugh MacIsaac

Mayflies

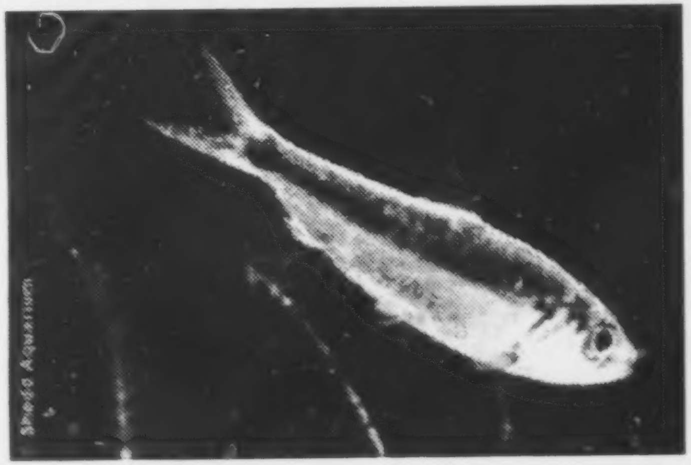
Fish Community



Forage Fish



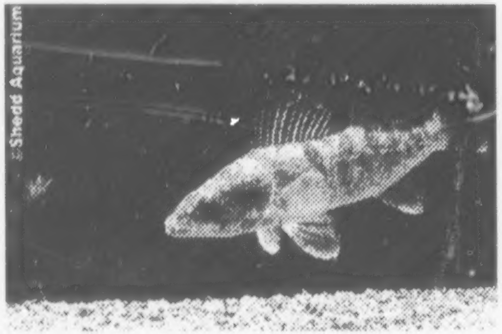
Shedd Aquarium



Shedd Aquarium

- Native species
  - Lake Herring
  - Sculpins
  - Emerald Shiners
  - Spottail Shiners
- Non- Native species
  - Alewife
  - Gizzard Shad
  - Gobies
  - Smelt

Trends In Walleye and Yellow Perch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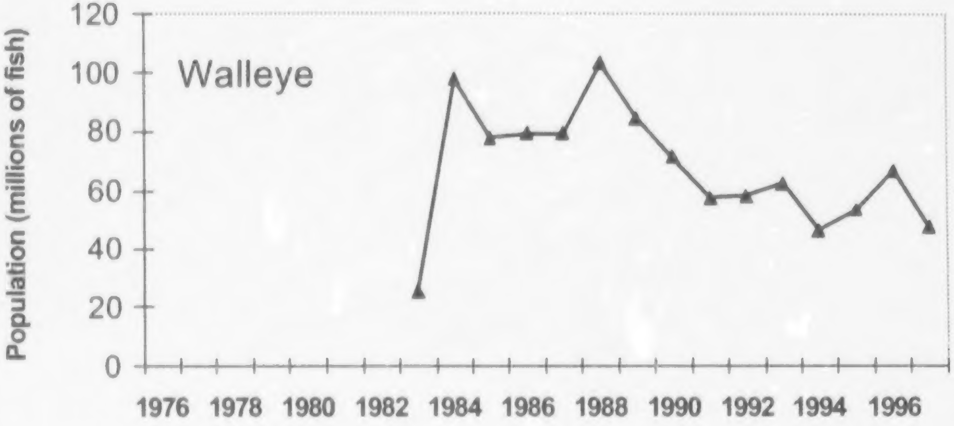

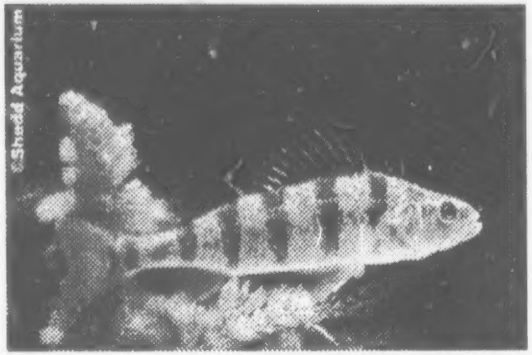
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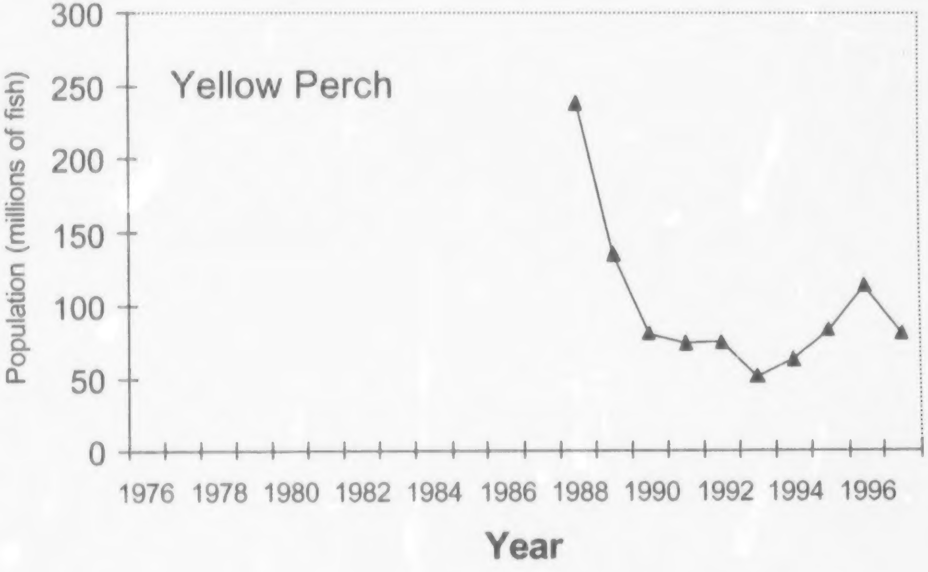
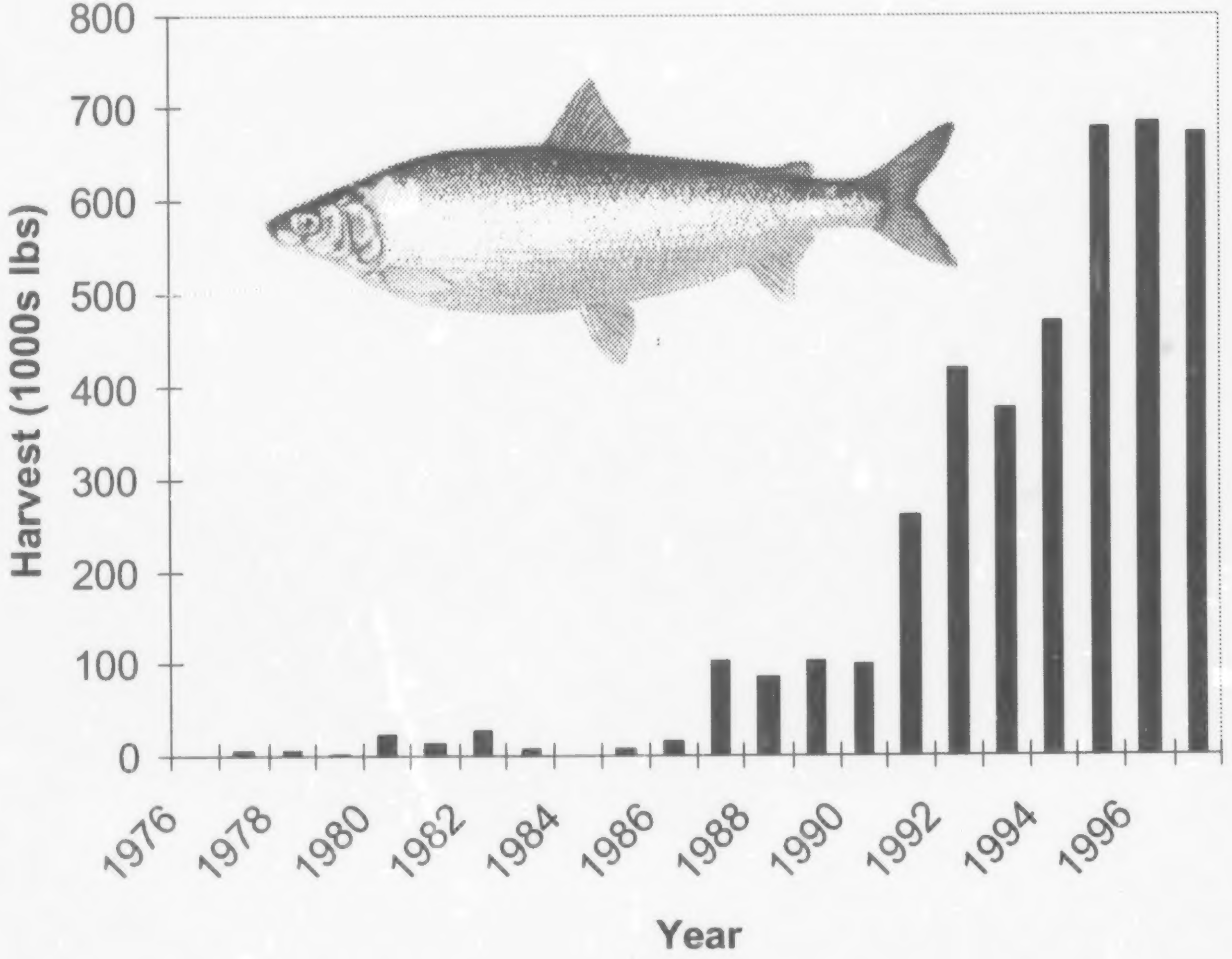
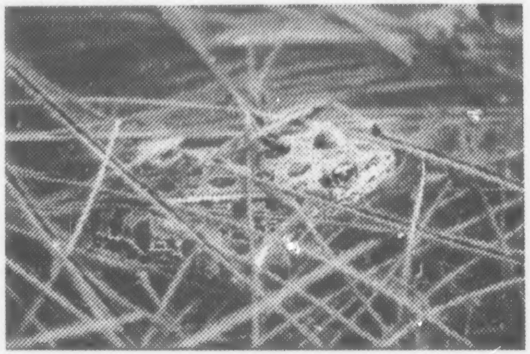


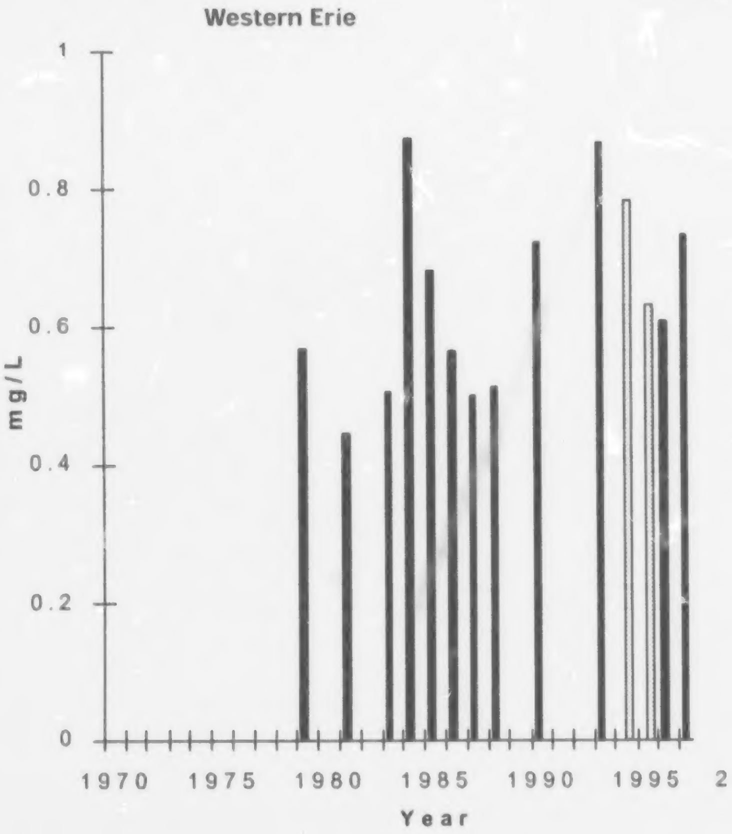
Trends in Lake Whitefish

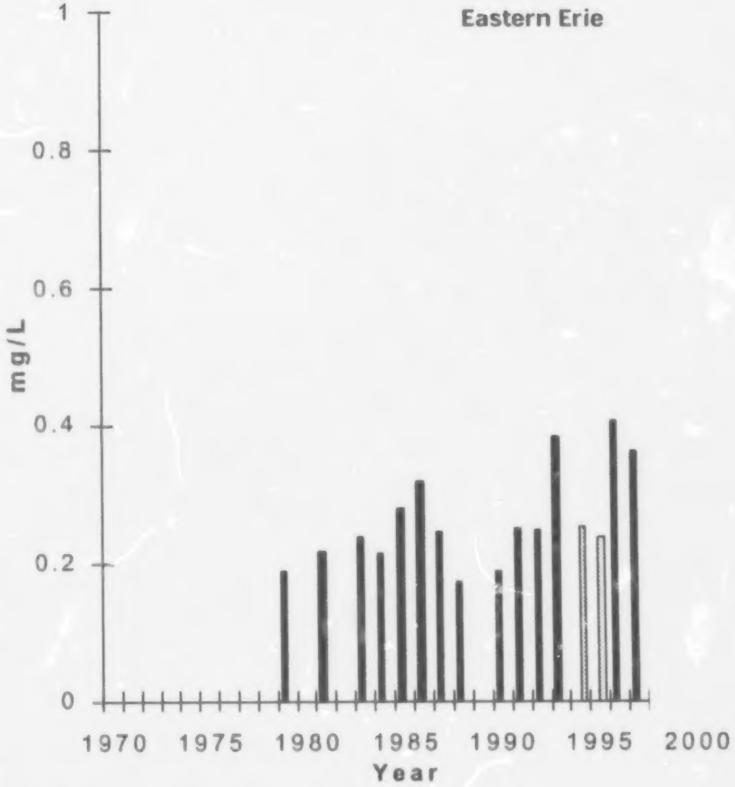




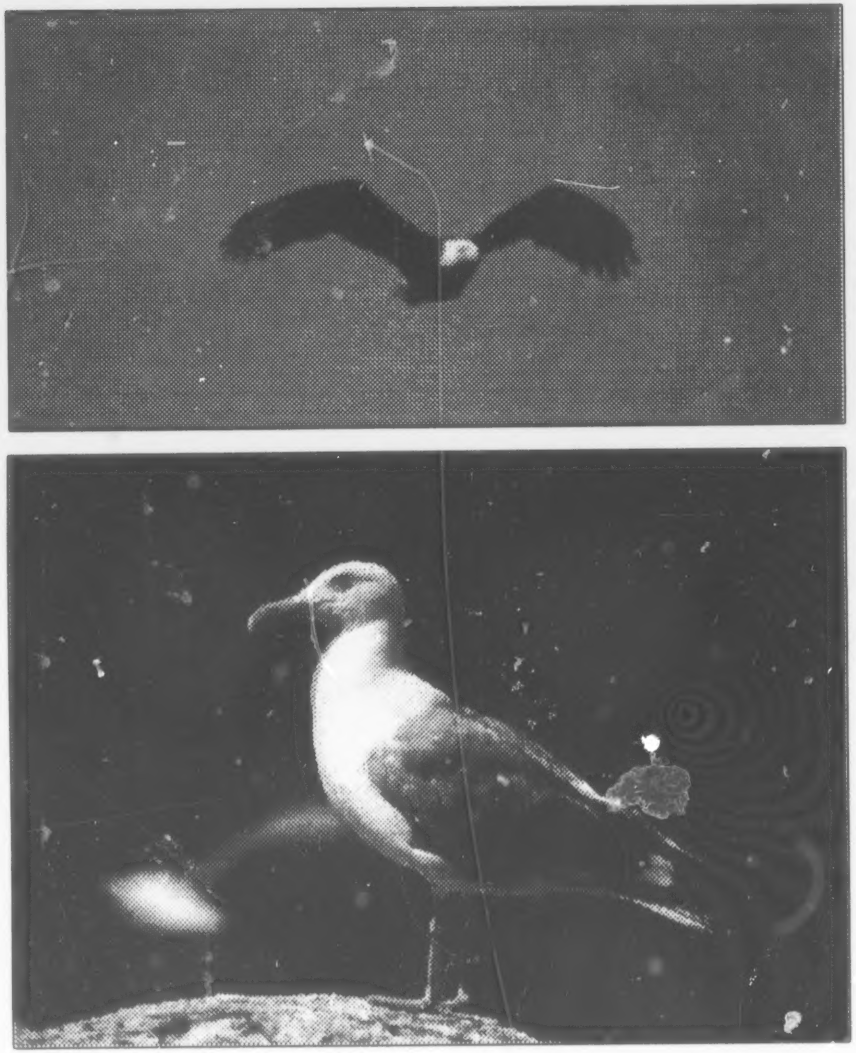
Amphibians and Reptiles

Nitrates

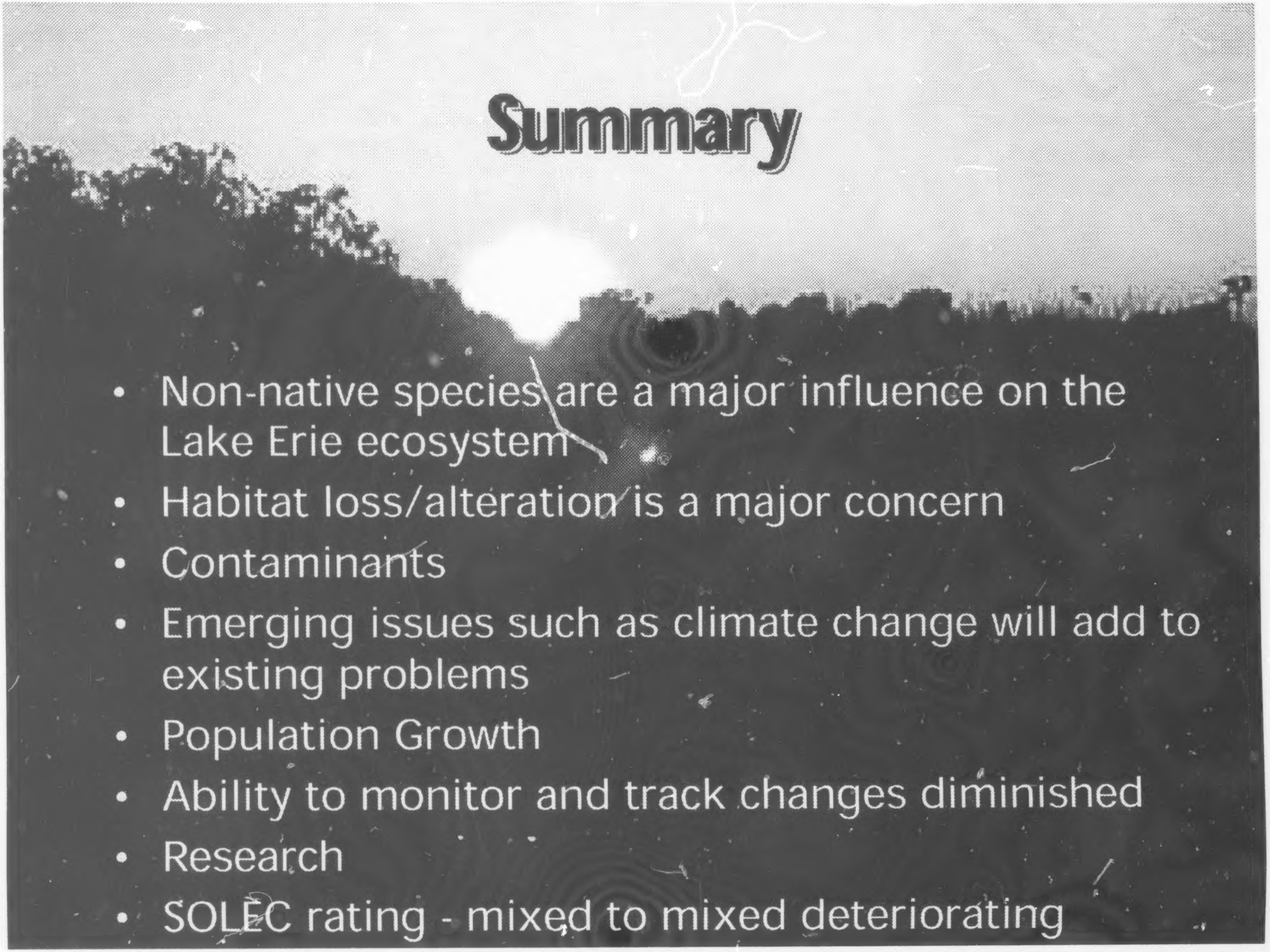




Birds



- Bald Eagles
- Colonial Waterbirds
- Some populations declining despite gains in contaminants
- Habitat loss: major concern
- Non-native species



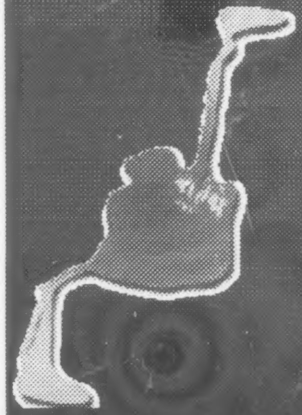
Summary

- Non-native species are a major influence on the Lake Erie ecosystem
- Habitat loss/alteration is a major concern
- Contaminants
- Emerging issues such as climate change will add to existing problems
- Population Growth
- Ability to monitor and track changes diminished
- Research
- SOLEC rating - mixed to mixed deteriorating

St. Clair River-Lake St. Clair-Detroit River Corridor

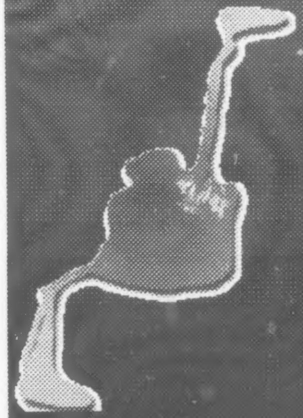
State of the Lake Ecosystem Conference
October 19, 2000
Hamilton, Ontario

Presented by
Gary Johnson
Ontario Ministry of the Environment
on behalf of Environment Canada, U.S. Environmental Protection Agency, Michigan Dept. of Environmental Quality, and Ontario Ministry of the Environment



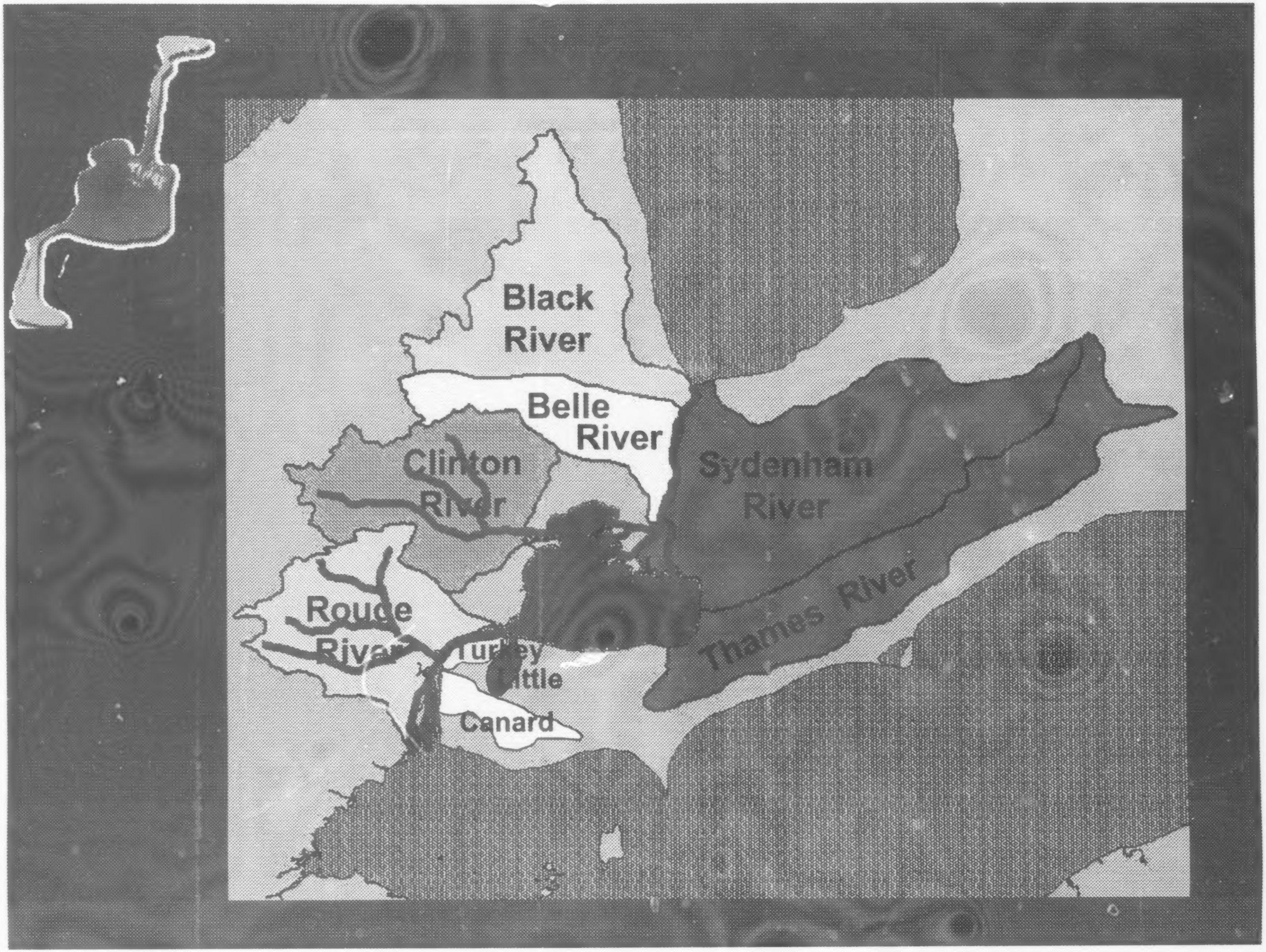
Presentation Overview

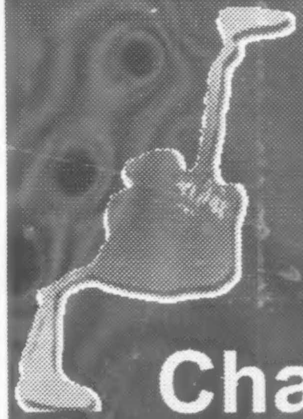
- Overview of Corridor
- Four Agency Agreement
- Beneficial Use Impairments and indicators of water quality
- Pressures on the System and Activities to Mitigate Them



Huron-Erie Corridor

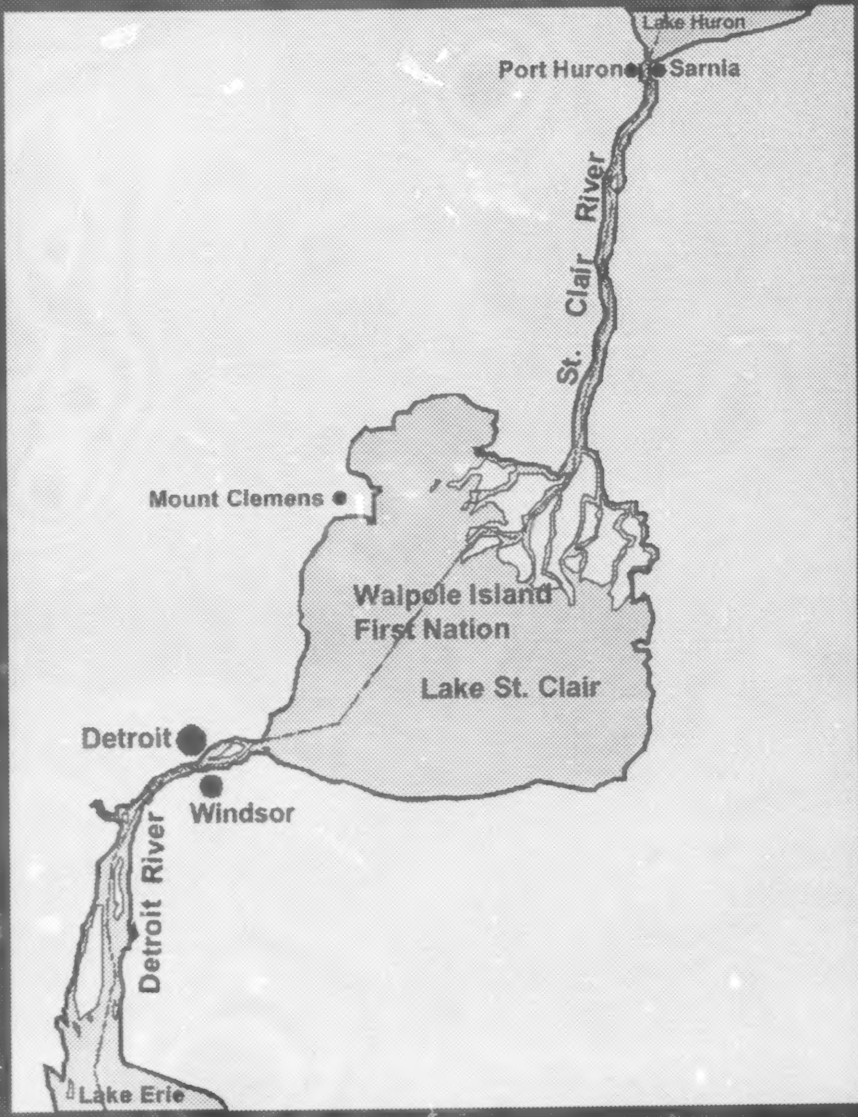
U.S. Army Corps of Engineers, Detroit District


Black River
Belle River
Clinton River
Sydenham River
Thames River
Rouge River
Turkey
Little
Canard



Characteristics of the Corridor

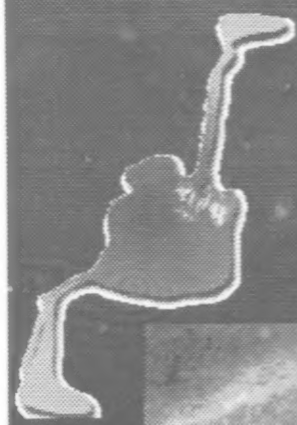
- Connecting channels
- Lake St. Clair
- Population centers
- Land use
- Resource uses
- Fish and wildlife


Lake Huron
Port Huron
Sarnia
St. Clair River
Mount Clemens
Walpole Island First Nation
Lake St. Clair
Detroit
Windsor
Detroit River
Lake Erie

Beneficial Use Impairments in the Corridor

- **Corridor-wide issues/indicators:**
  - Fish consumption advisories
  - Wetland losses (historical and current)
  - Degraded benthos
  - Contaminated sediments
  - Water Quality exceedances
  - Beach Closures
  - Drinking water

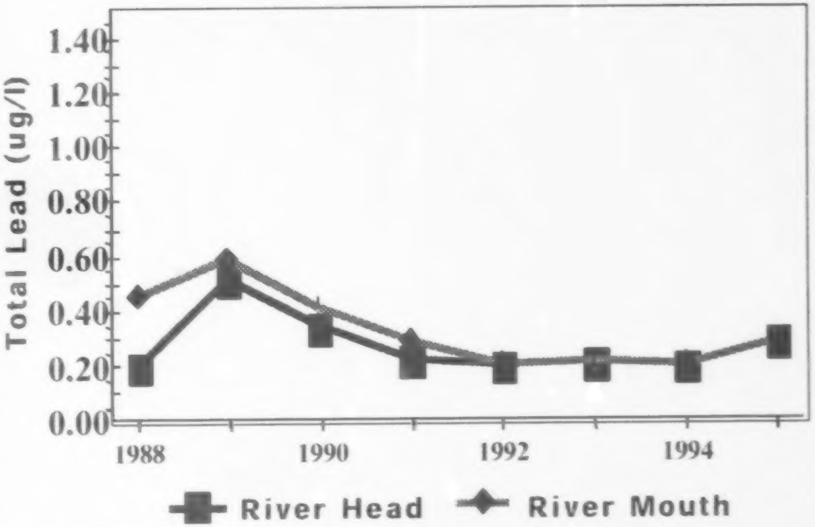
Water Quality Trends



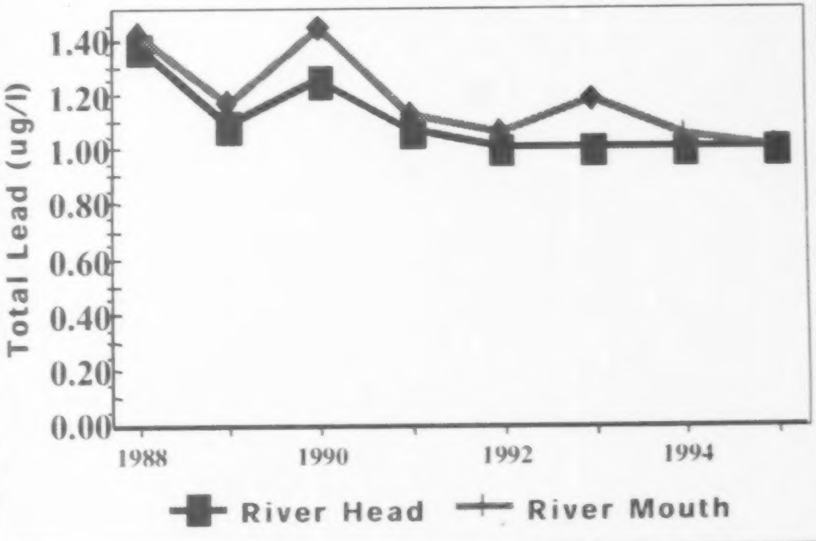
St. Clair River
Lake St. Clair
Detroit River

MI Human Health Std. = 14 ug/l
GLWQA Specific Obj. = 25 ug/l

St. Clair River - Lead



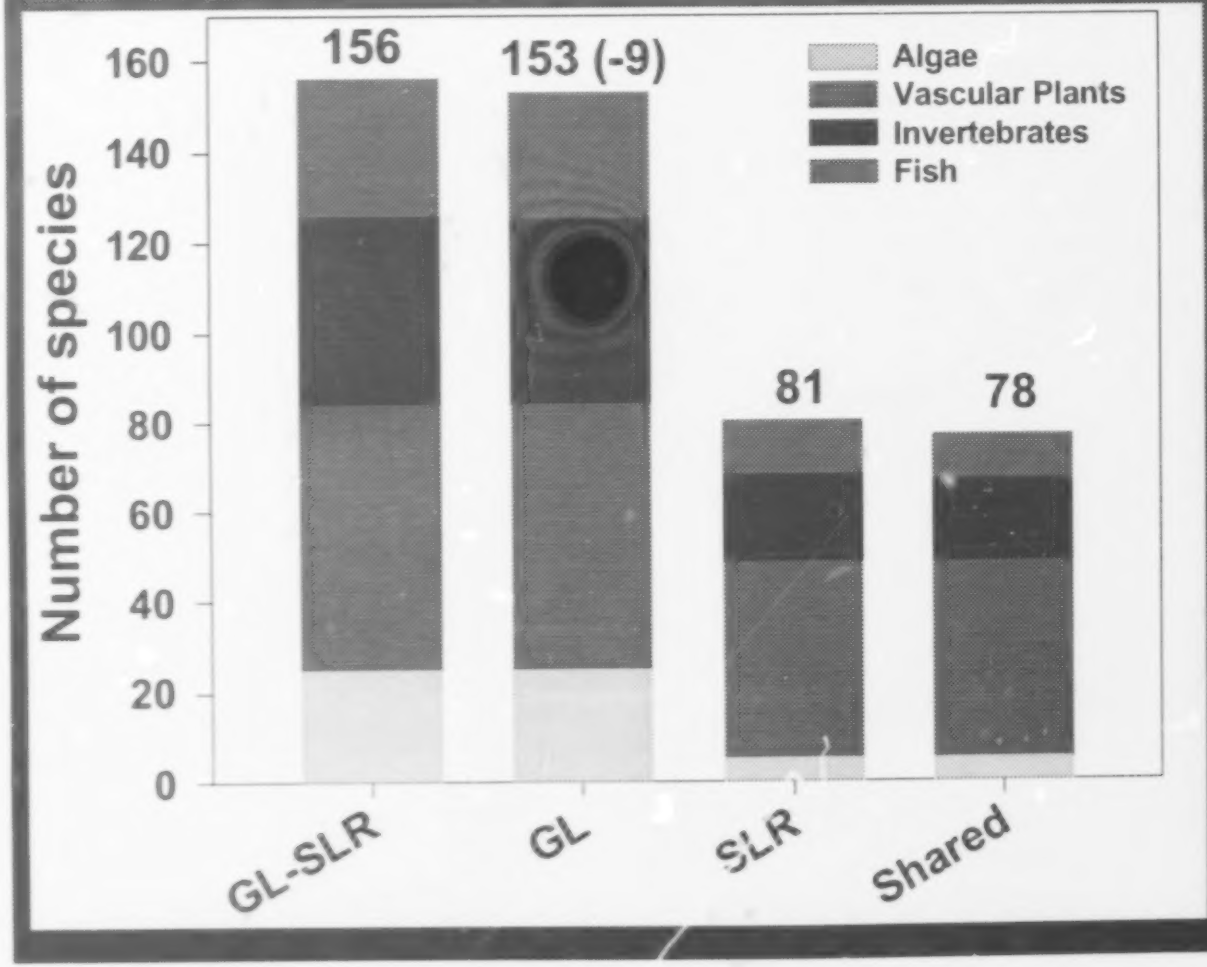
Detroit River - Lead



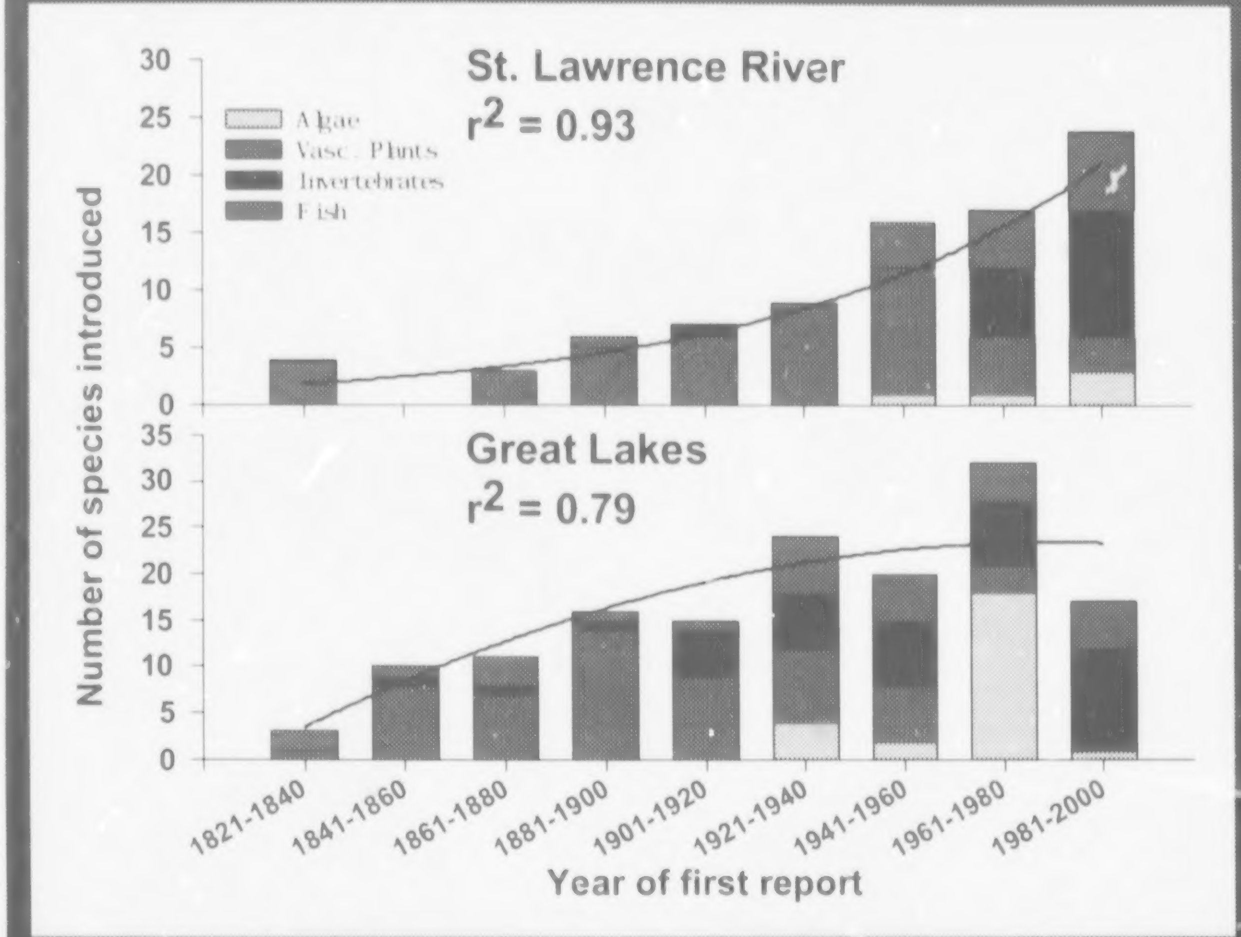
Methods

- Literature search
  - Scientific papers
  - Technical reports
  - Computerized databases
  - Web sites
  - Museum collections
- Database information
  - Species name
  - Year of first report
  - Site of first report
  - Origin of species
  - Vector of introduction
  - Distribution in river
  - Density (in progress)

Alien species in the Great Lakes - St. Lawrence River



Half the non-indigenous species have been reported in the St. Lawrence River



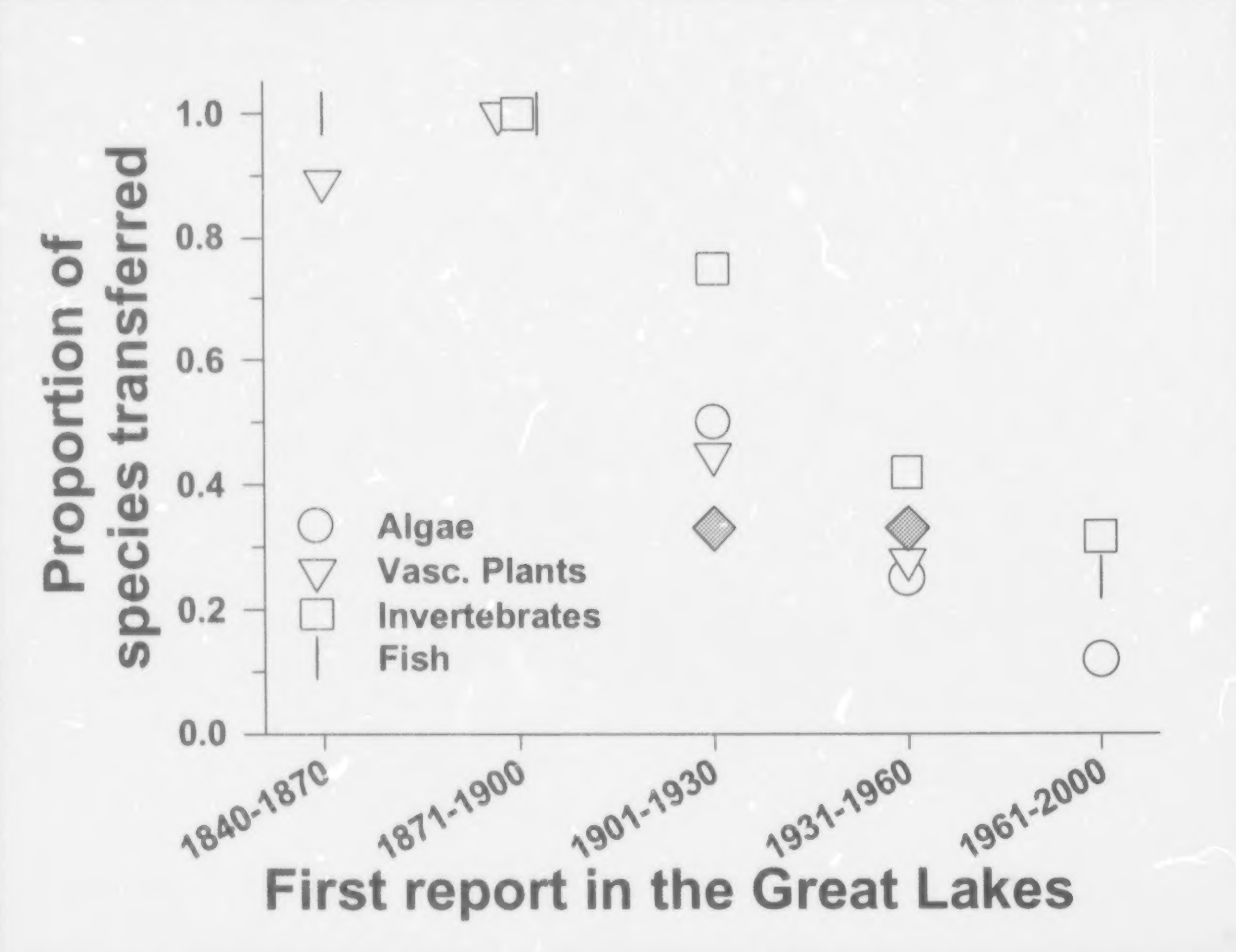
Average rate
~ 1 species
per year

Trend in species introductions since 1820

Time for Transfer of non-native Species Between the Great Lakes and the St. Lawrence River

Taxonomic Groups	Species (n)	Time difference (years)		
		Mean	Min.	Max.
Algae	4	32.0	17	69
Vasc. Plants	32	50.0	2	123
Invertebrates	16	40.6	2	95
Fishes	10	39.6	7	96
Vasc. Plants (upstream transfer)	12	-25.2	-3	-129

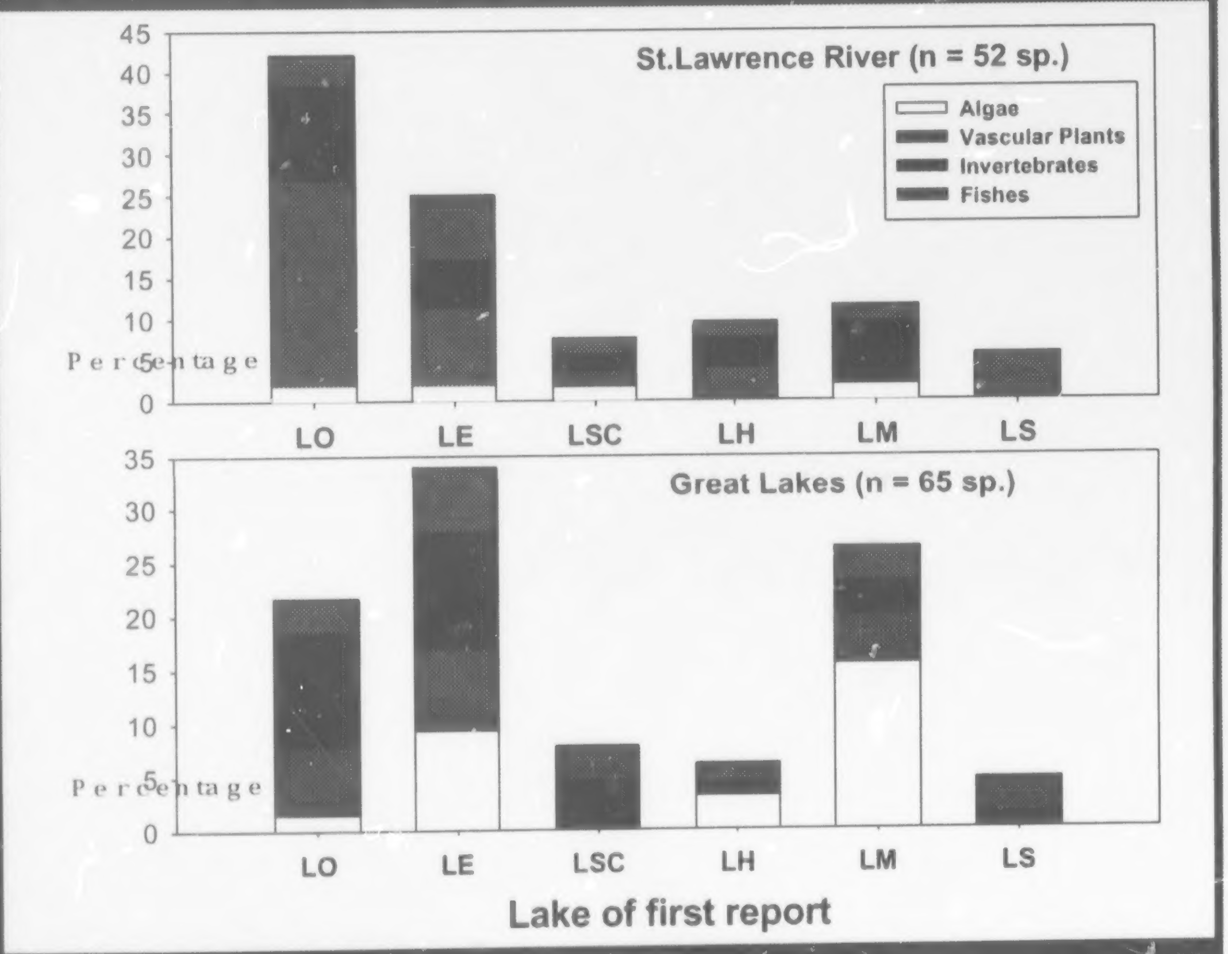
Proportion of species transferred over time



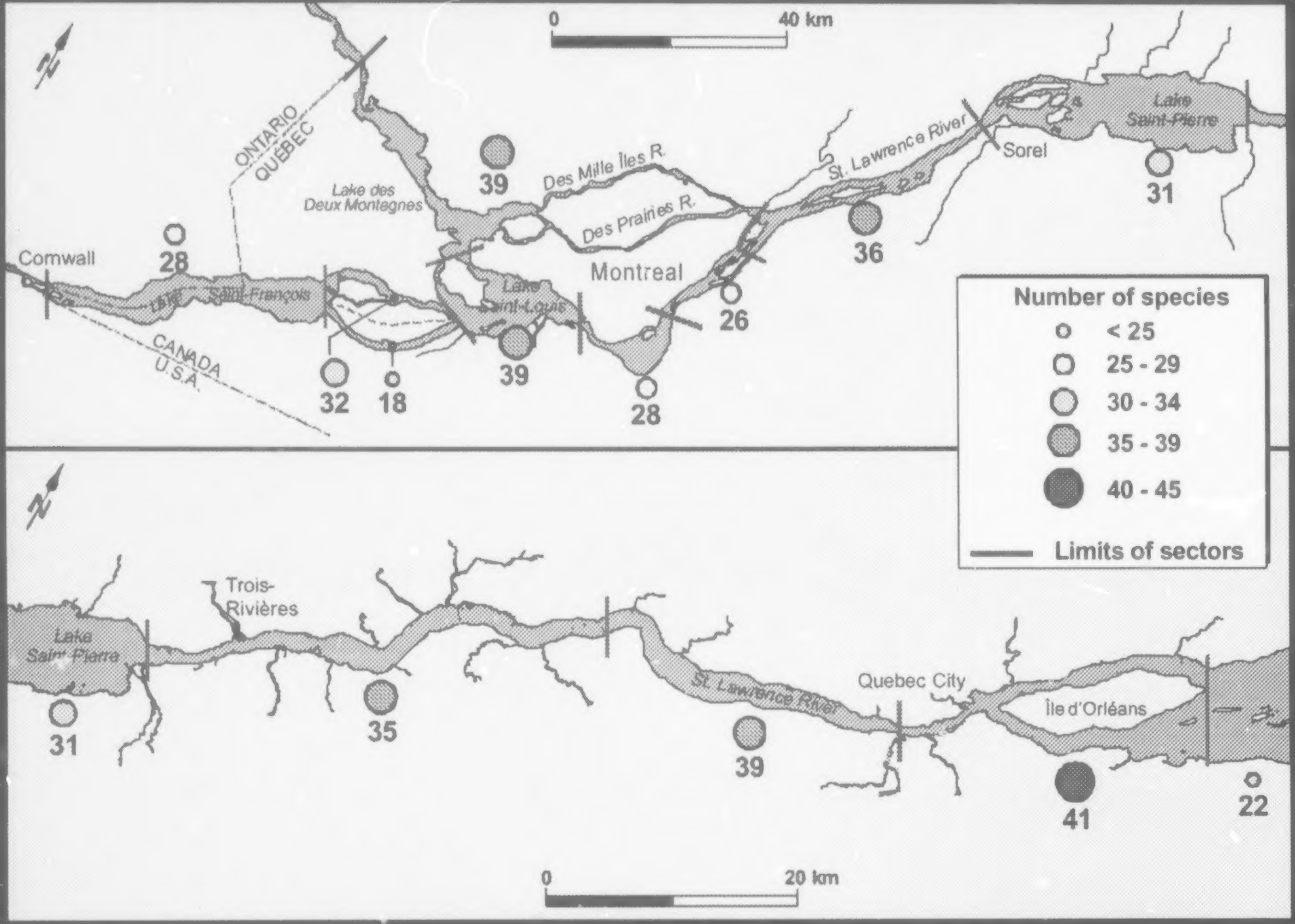
Species transfer takes time !

Species Transfer in Relation to the Site of First Report

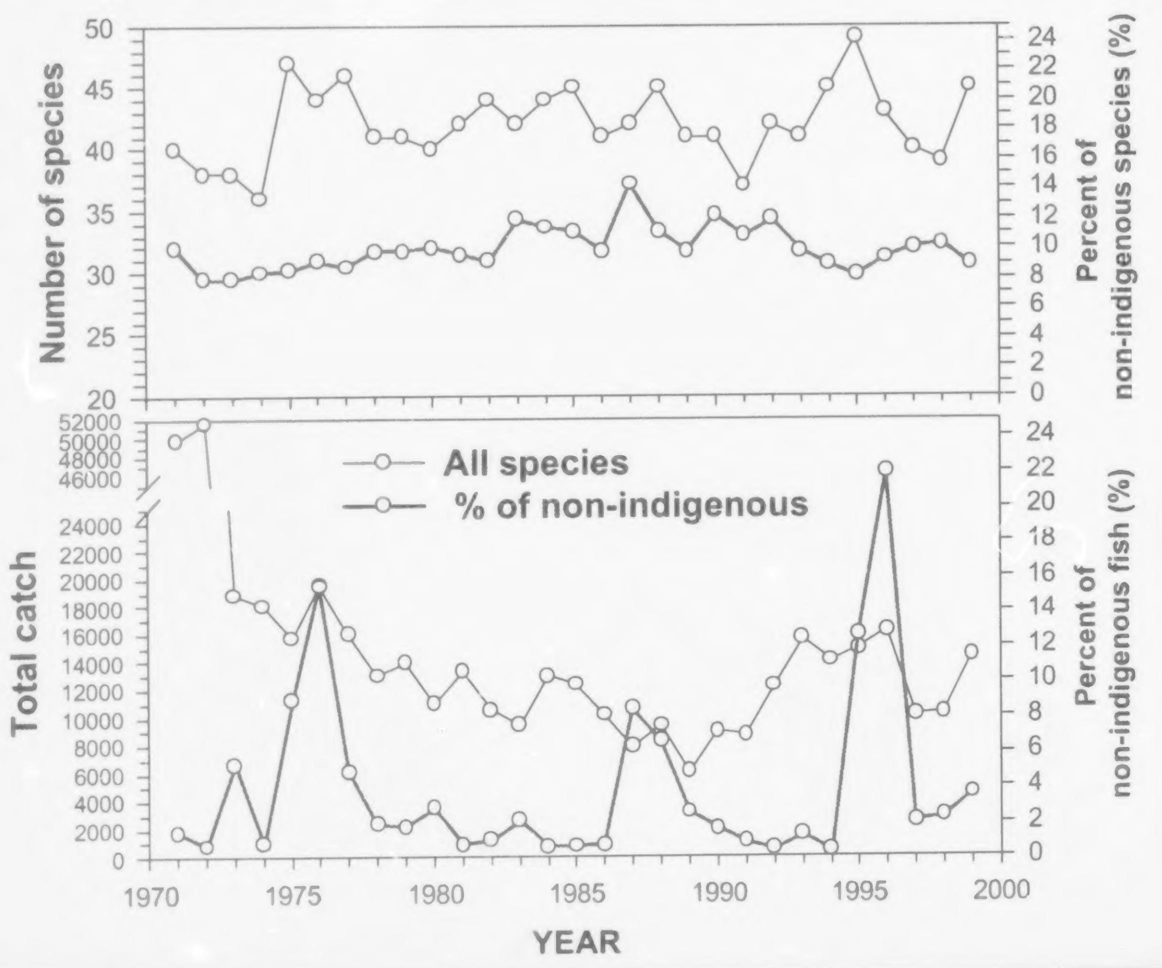
Species transfer is inversely related to distance of lake site of introduction



Hot spots of non-native species along the St. Lawrence River


0
40 km
ONTARIO
QUÉBEC
Lake des Deux Montagnes
39
Des Mille Îles R.
Des Prairies R.
St. Lawrence River
Sorel
Lake Saint-Pierre
31
Cornwall
28
Lake Saint-François
Lake Saint-Louis
Montreal
36
26
CANADA
U.S.A.
32
18
39
28
Number of species
< 25
25 - 29
30 - 34
35 - 39
40 - 45
Limits of sectors
Trois-Rivières
Lake Saint-Pierre
31
35
St. Lawrence River
Quebec City
Île d'Orléans
39
41
22
0
20 km

Non-indigenous Fish in the SLR Fish Community Near Quebec City



Species invasion: a probabilistic process

- ~50% of the species introduced in the Great Lakes reported in the St. Lawrence River
- Introduction rate : ~ 1 sp. per year
- Downstream transfer - main source of introduction in the St. Lawrence River
- % of species transfer increased with time

Reports of introduced species in the St. Lawrence River will remain high over the next decade

Guidelines for Water Ballast Exchange Should Be Rigorously Applied and Compliance Should Be Enforced for the St. Lawrence River

	Species introduced			
	Vectors			
Time period	Shipping	Others	Unknown	Total
1901-1910	2	5		7
1911-1920	1	8		9
1921-1930	1	7	2	10
1931-1940	5	9		14
1941-1950	2	5	4	11
1951-1960	2	6	2	10
1961-1970	10	4	1	15
1971-1980	10	4	3	17
1981-1990	9	2	1	12
1991-2000	4	0	2	6

Perspectives

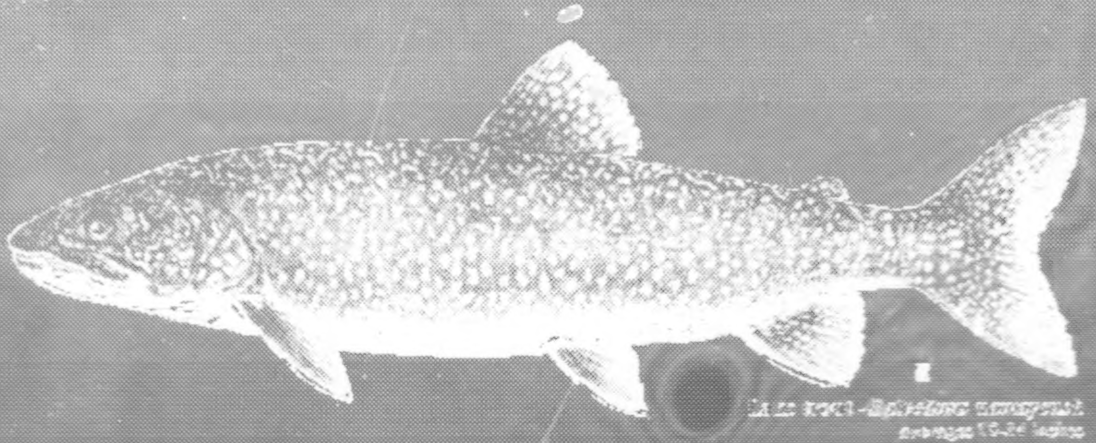
- Upstream transfer - a non-negligible source of species introductions in the GL (~10%)
- Insufficient data to assess or predict potential impact of non-indigenous species in the river
- Validate the information on non-indigenous species presence and distribution

If you give them time they will invade

- The Biodiversity of the St. Lawrence River is under stress

- The problem of exotic species introductions is getting worse due to downstream transfer from the Great Lakes

The State of Lake Ontario



Lake Trout Rehabilitation

Lake Trout

- Only salmonine native to all 5 lakes
- Apex predator
- Requires oligotrophic conditions
- Requires clean spawning substrate
- Long life span
- Diversity within specie
- Integrates many ecosystem components

Lake Ontario Committee Lake Trout Rehabilitation Goal

To rehabilitate the lake trout population of Lake Ontario such that the adult spawning stock(s) encompasses several year classes, sustains itself at a relatively stable level by natural reproduction, and produces a usable annual surplus

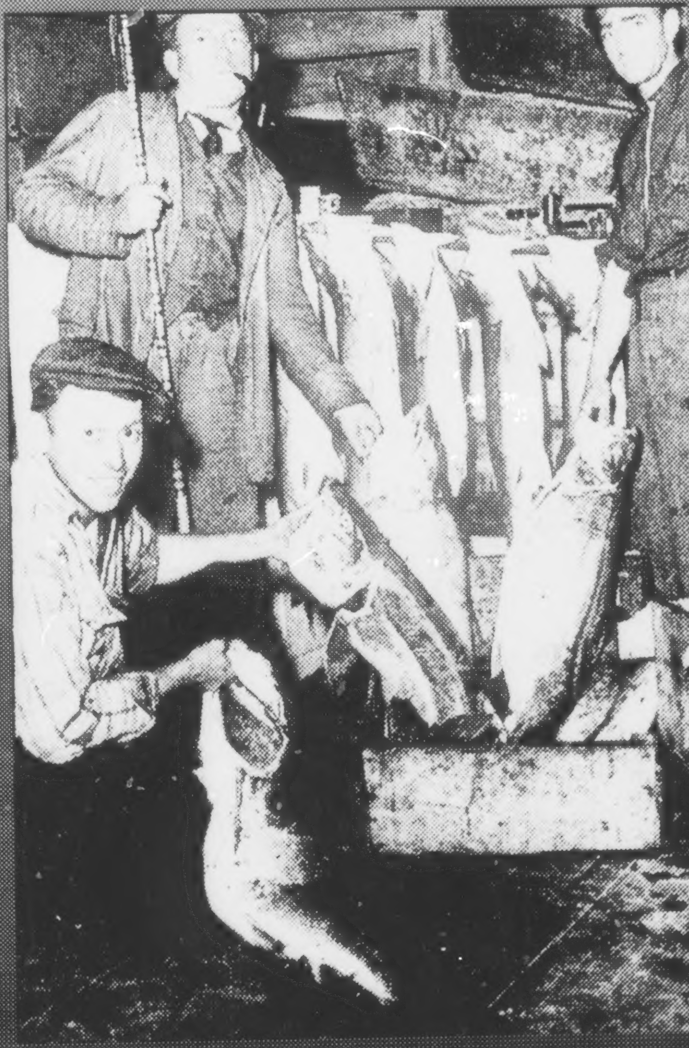
Proposed Lake Ontario
LaMP / SOLEC
Lake Trout Indicator

Objective: Healthy lake trout populations sustained through natural reproduction

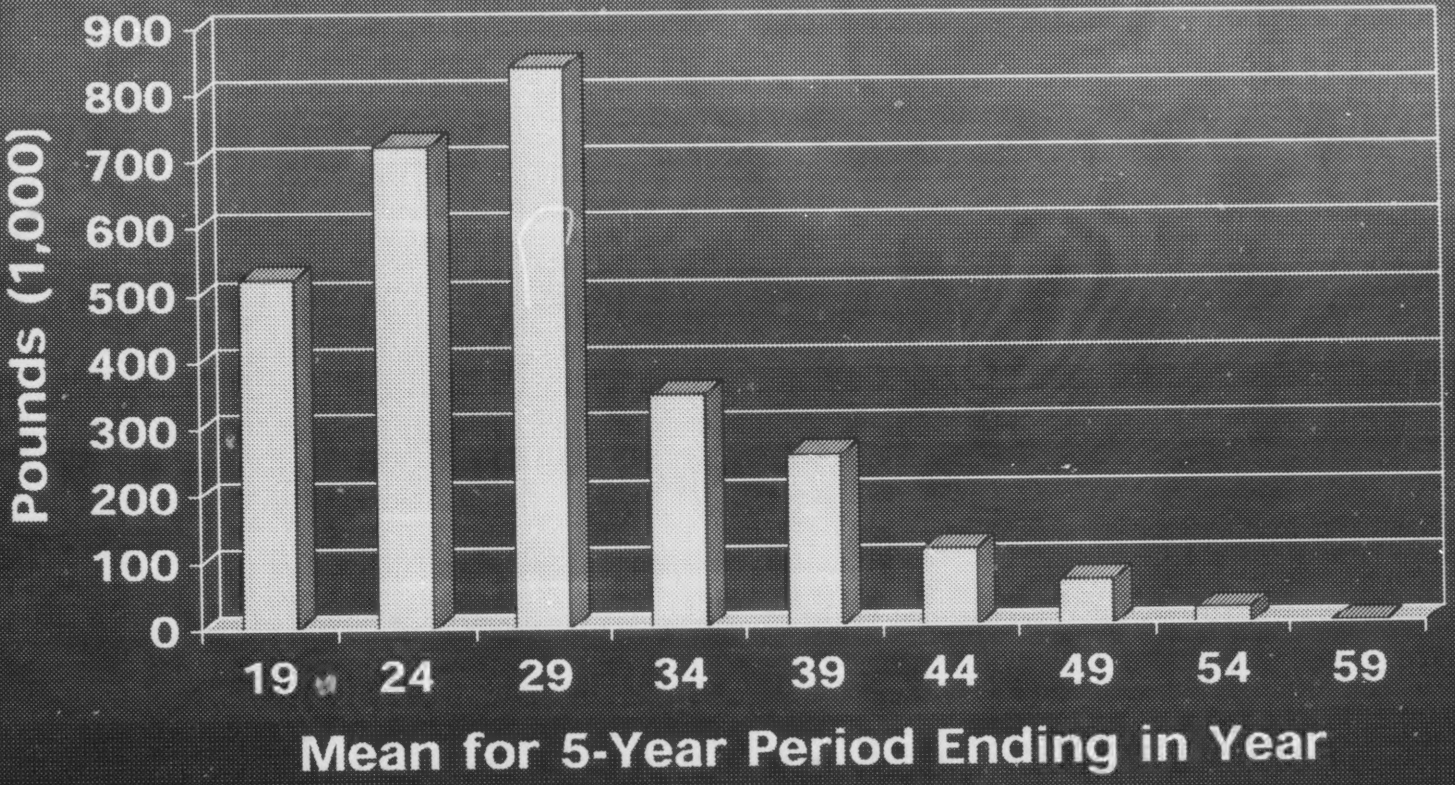
Native lake trout were extirpated from all* of the lakes except Lake Superior

WHY?

Fishing



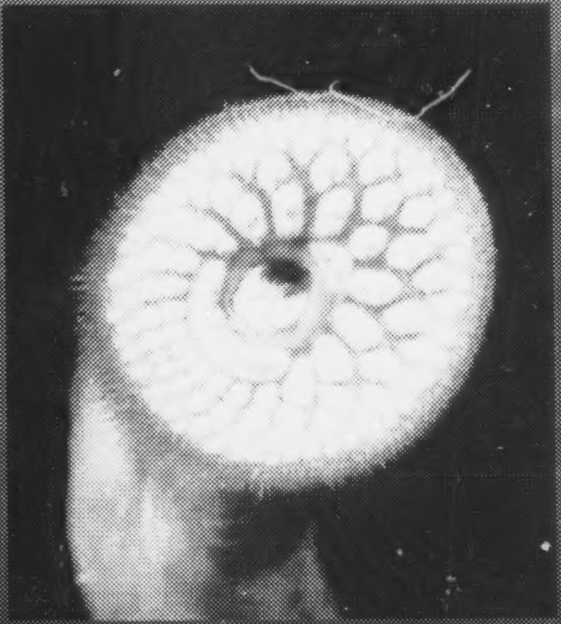
Lake Ontario Lake Trout Commercial Landings

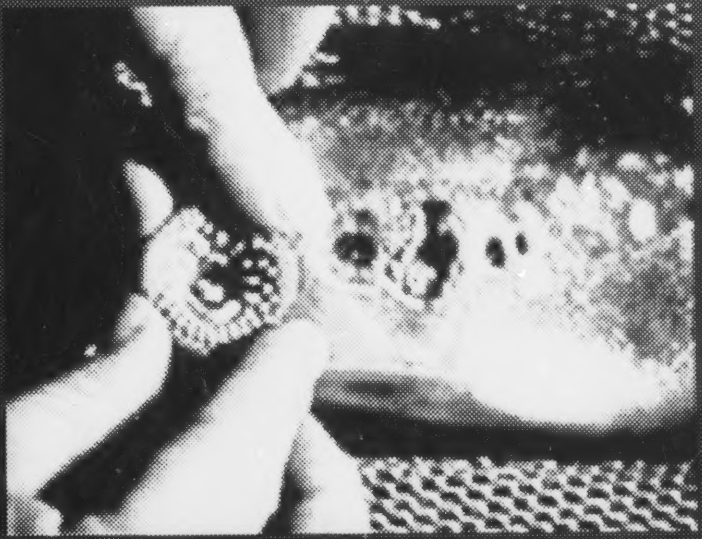


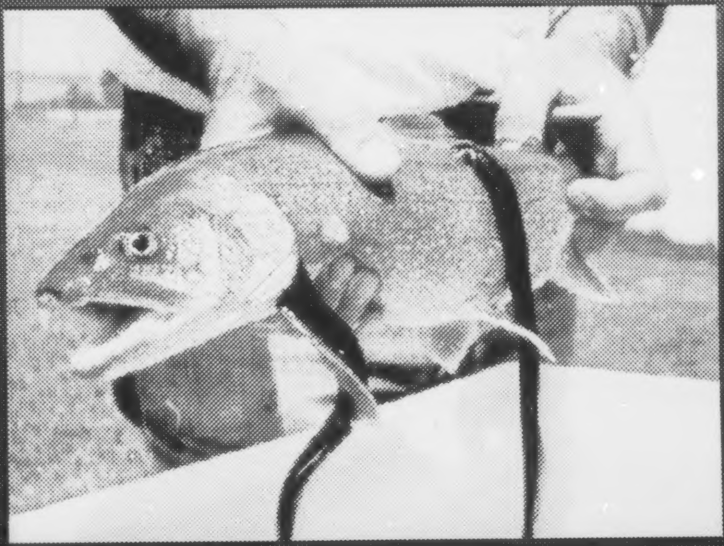
Source: Baldwin et al. 1979

Habitat Loss

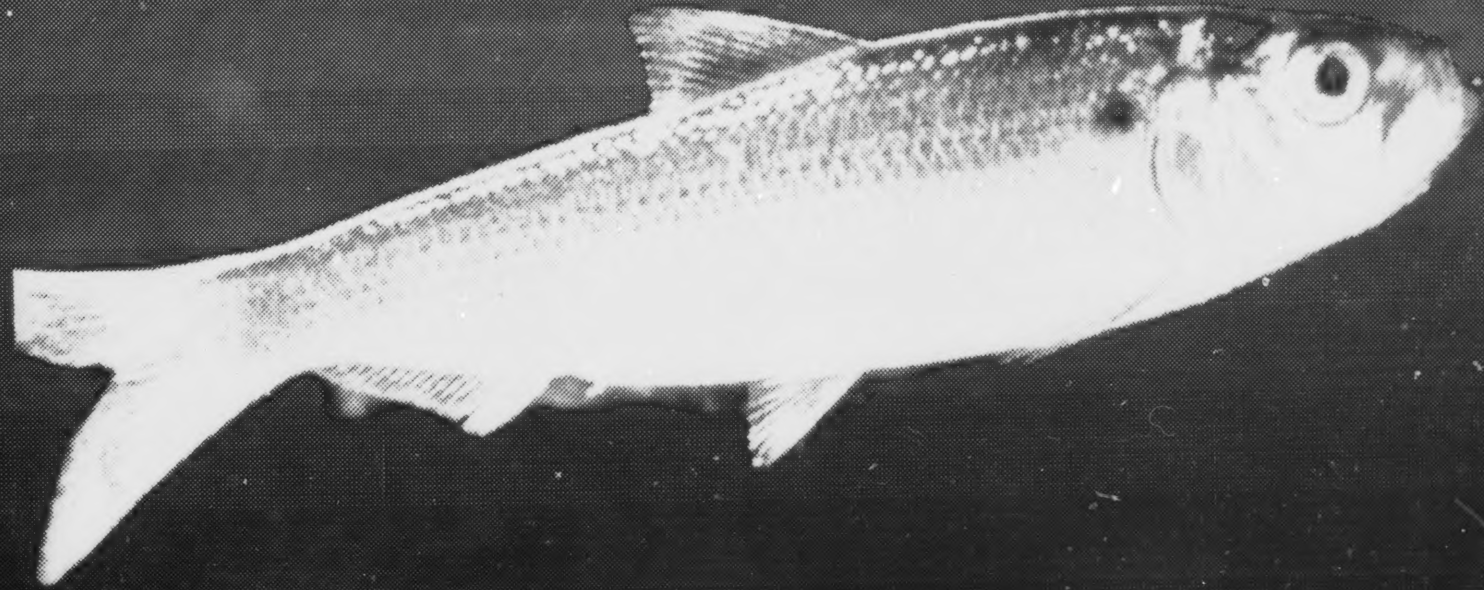
Sea Lamprey







Other Invasive Species



Contaminants

- Contamination by dioxin-like chemicals began in 1930s and peaked in late 1960s
- Levels may have been high enough for 100% fry mortality from 1945 – 1975 (blue sac syndrome)
- Levels below threshold for adverse effects after 1991

Research by P. Cook, P. Guiney, R. Peterson, L. Burkhard and others

Proposed Measures
Lake Ontario LaMP

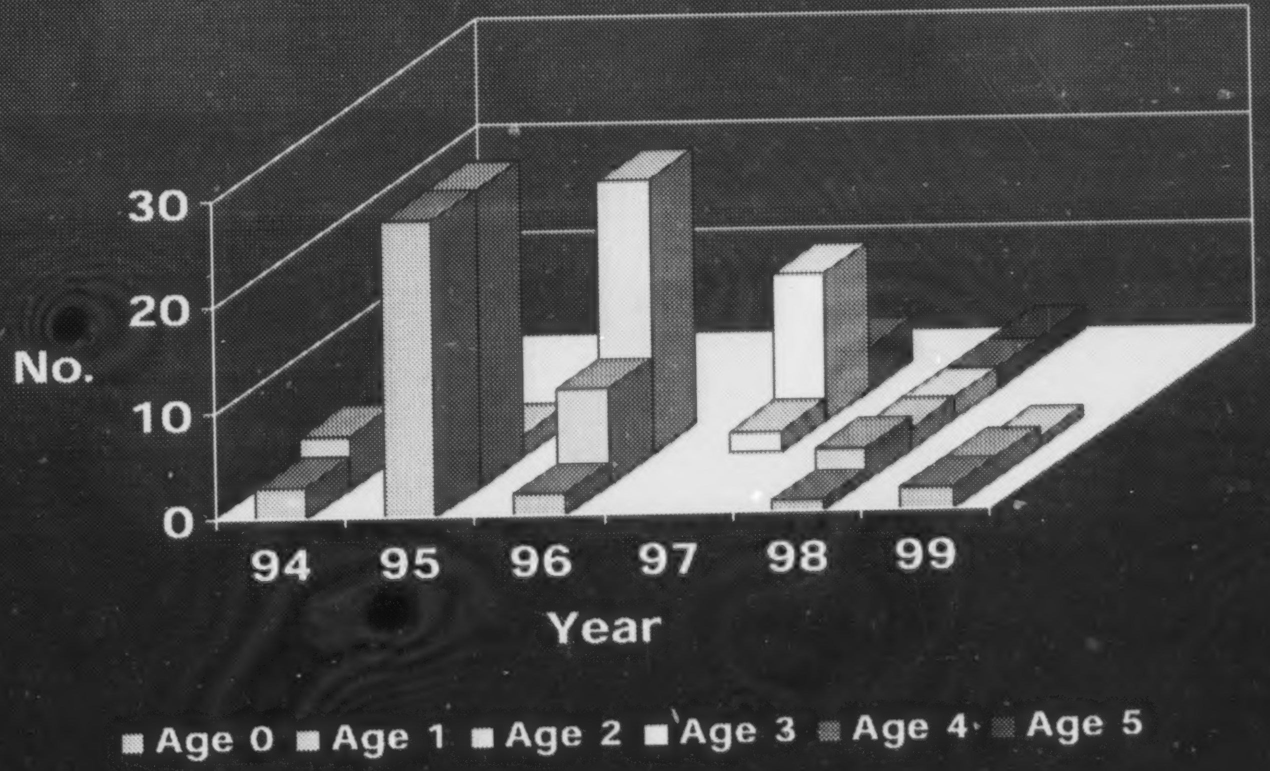
- Abundance of naturally produced lake trout
- Mature, naturally produced females
- Number of lake trout harvested
- Lamprey wounding

Proposed Measure:

Abundance of naturally produced lake trout

26 wild age 2 lake trout in summer bottom trawls in N.Y. waters

Naturally-spawned Lake Trout Captured in Trawls



Data Source: USGS and NYSDEC

Proposed Measure:

Abundance of mature,
naturally produced females

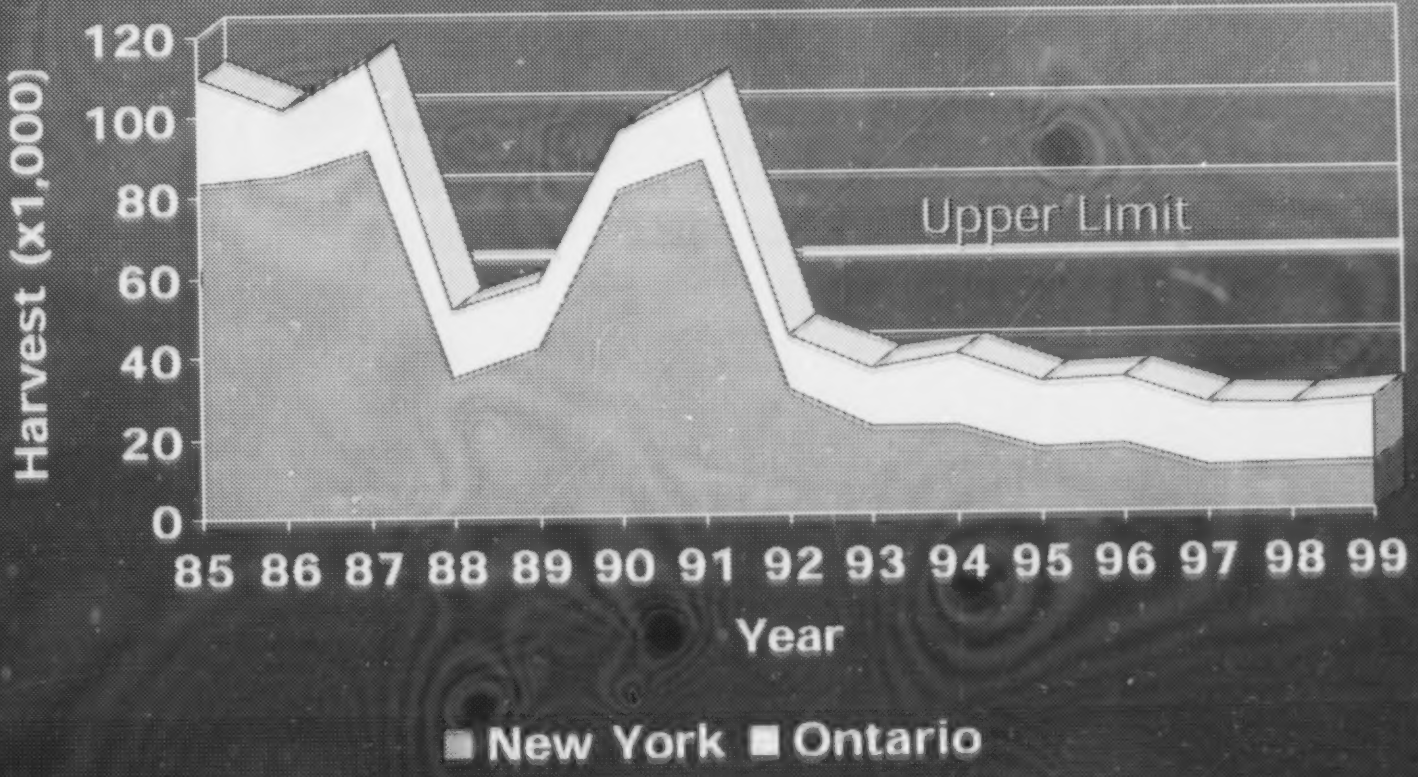
Minimum catch per unit effort (CPUE)
in assessment nets

Proposed Measure:

Number of lake trout harvested

Maximum 30,000 per country

Lake Trout Sport Harvest



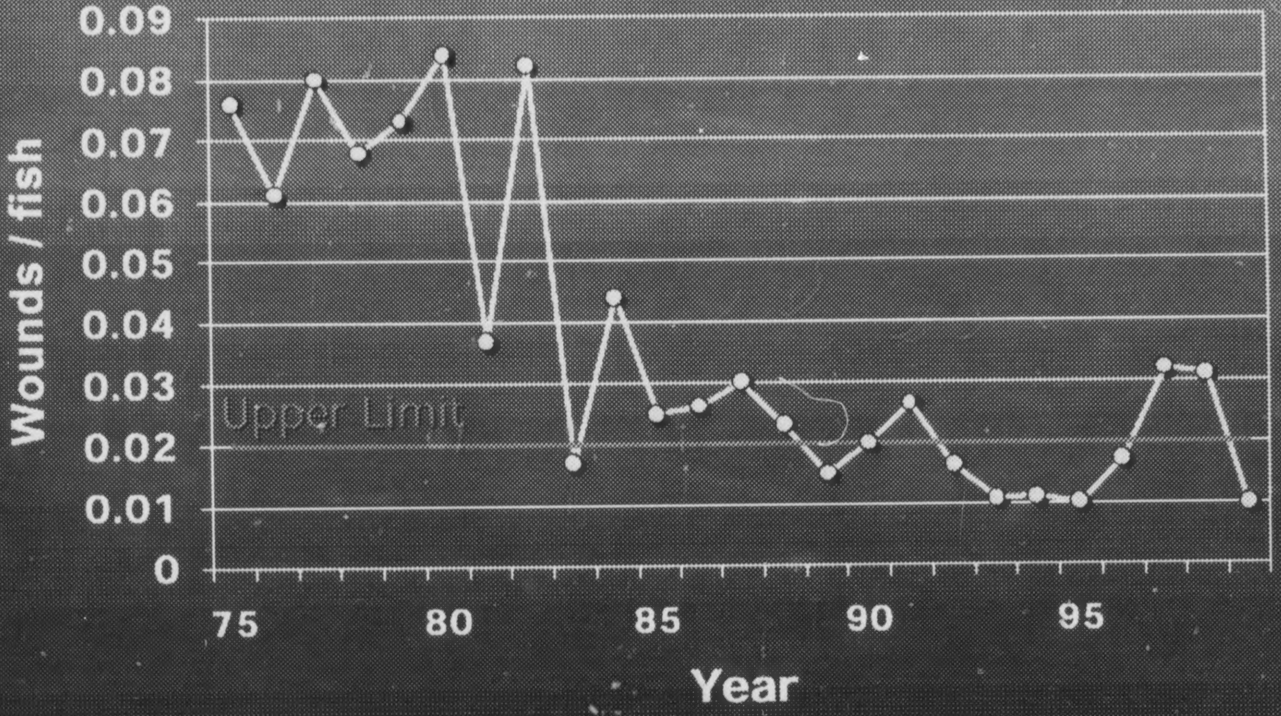
Data Sources: NYSDEC and OMNR

Proposed Measure

Sea Lamprey Wounding

Maximum two A1 wounds per 100 fish

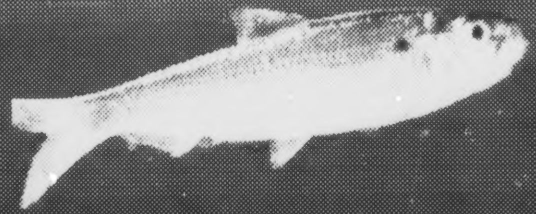
Sea Lamprey Wounds on Lake Ontario Lake Trout



Data Source: USGS and NYSDEC

The Alewife Paradox

- Dominant dietary item for lake trout (and all other trout and salmon)



- BUT, alewives prey on lake trout fry
- Probable linkage with Early Mortality Syndrome

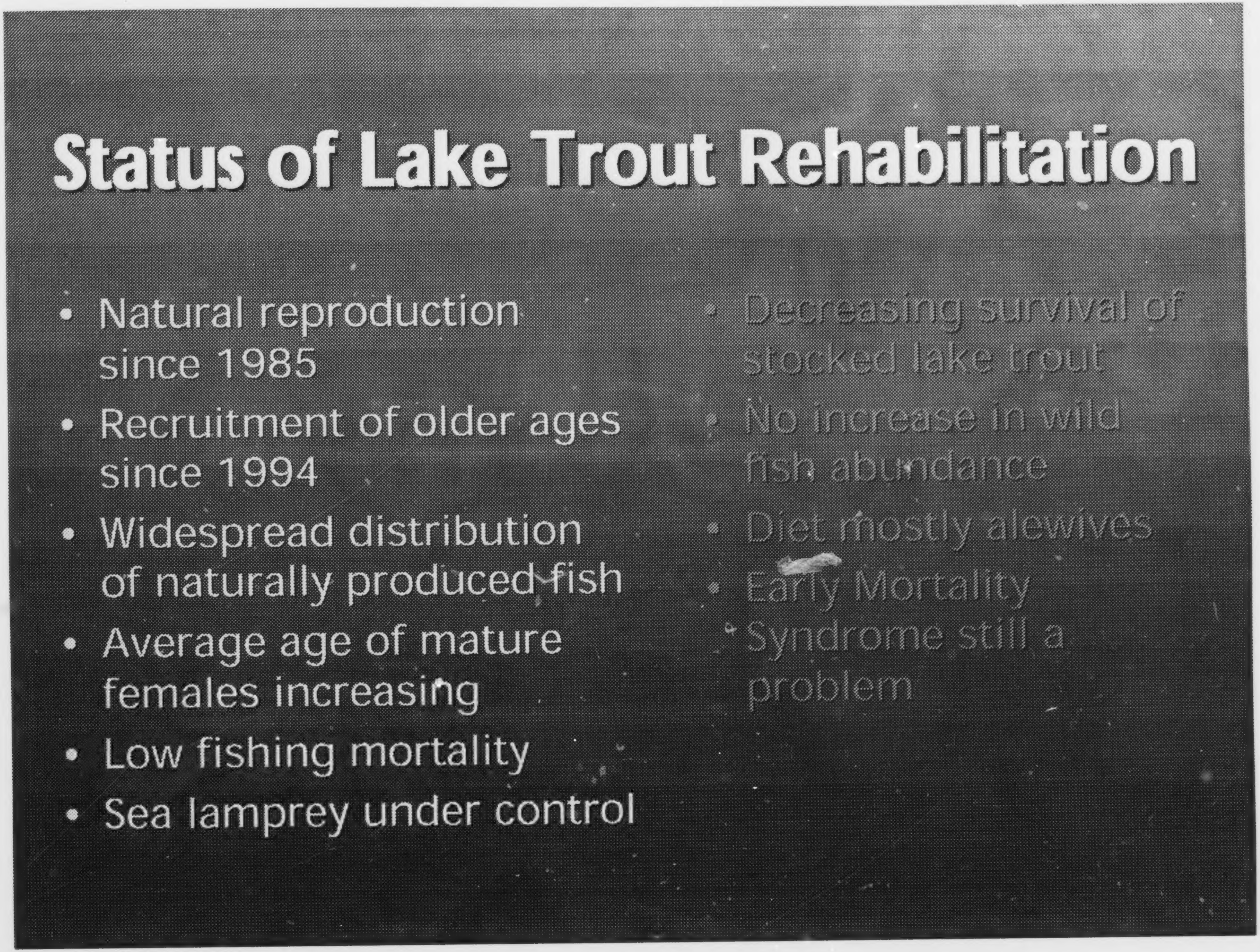
Early Mortality Syndrome

- Caused by thiamine (vitamin B1) deficiency
- Up to 100% mortality of fry
- Linked to diet rich in alewives (thiaminase)

A Fisheries Management Dilemma…

The prey species that supports an economically valuable fishery…

Inhibits the recruitment of lake trout and other native species



Status of Lake Trout Rehabilitation

- Natural reproduction since 1985
- Recruitment of older ages since 1994
- Widespread distribution of naturally produced fish
- Average age of mature females increasing
- Low fishing mortality
- Sea lamprey under control

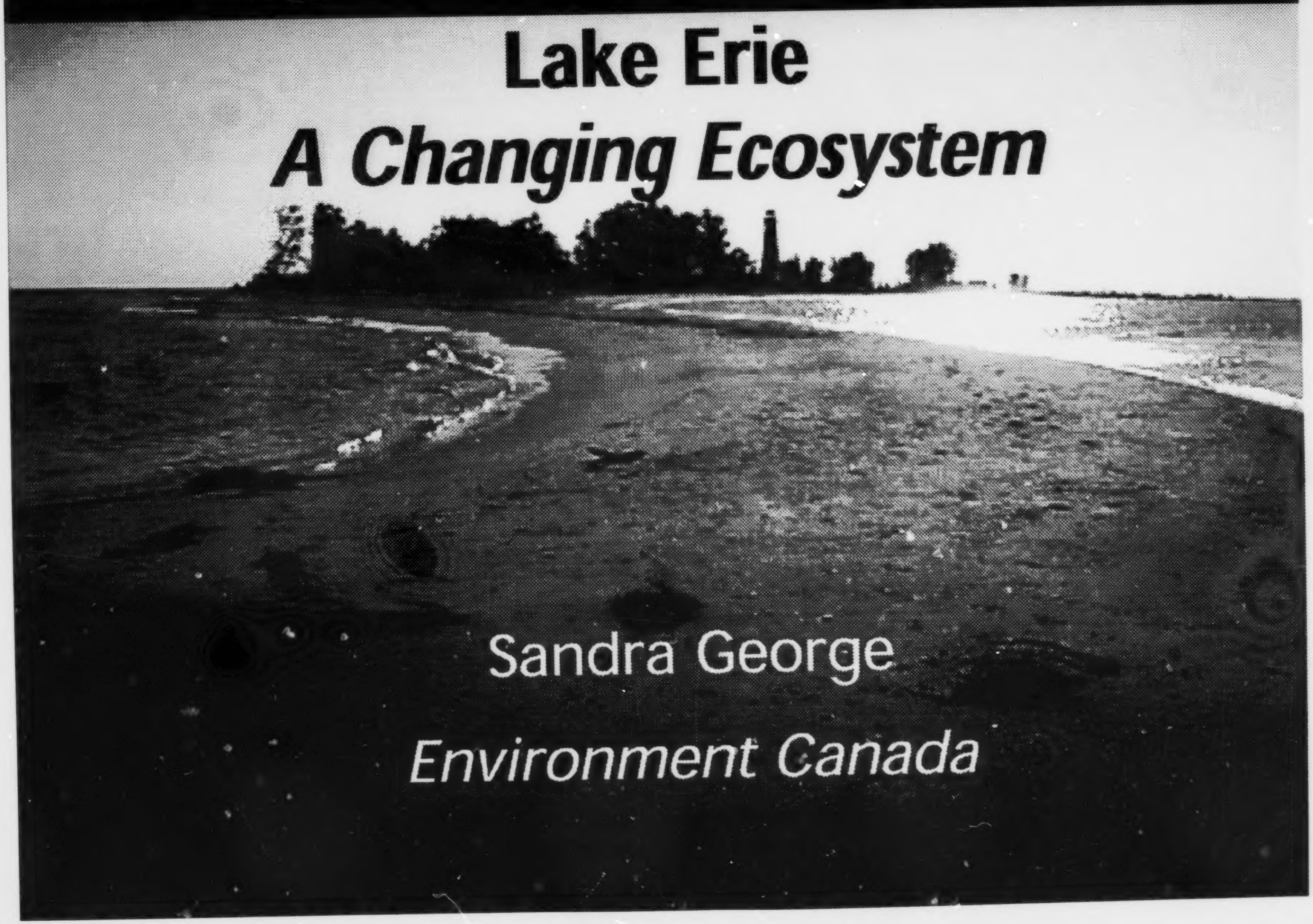
- Decreasing survival of stocked lake trout
- No increase in wild fish abundance
- Diet mostly alewives
- Early Mortality Syndrome still a problem

Keys to Future Success

- Improved survival of stocked lake trout
- Diversification of diet (bloaters?)
- Continued effective sea lamprey control
- Habitat protection
- Restrictive angling regulations
- Low contaminant levels

Proposed Lake Ontario LaMP Ecosystem Indicators

Critical Pollutant Indicators	Open Water YoY Fish Herring Gull Eggs Lake Trout
Lower Foodweb Biological Indicators	Nutrients Zooplankton Preyfish
Upper Foodweb Biological Indicators	Herring Gull Lake Trout Mink and Otter Bald Eagle



Lake Erie
A Changing Ecosystem

Sandra George

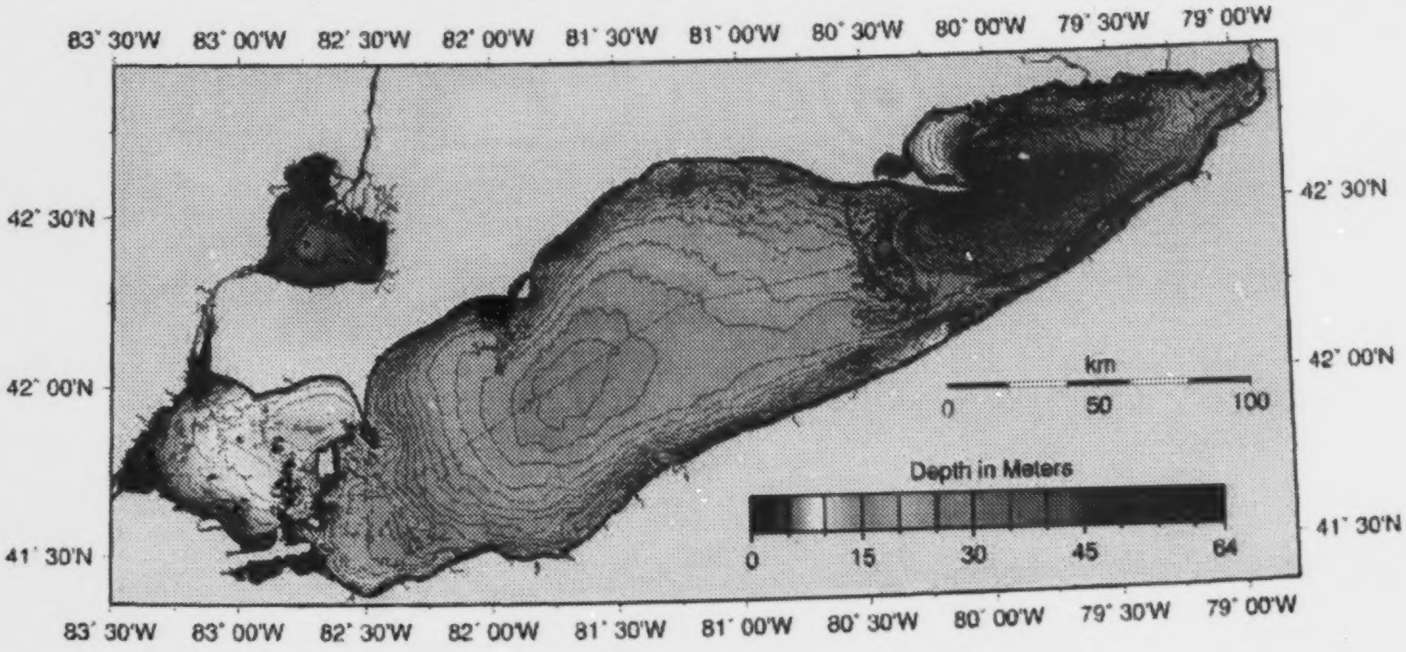
Environment Canada

Significant Features

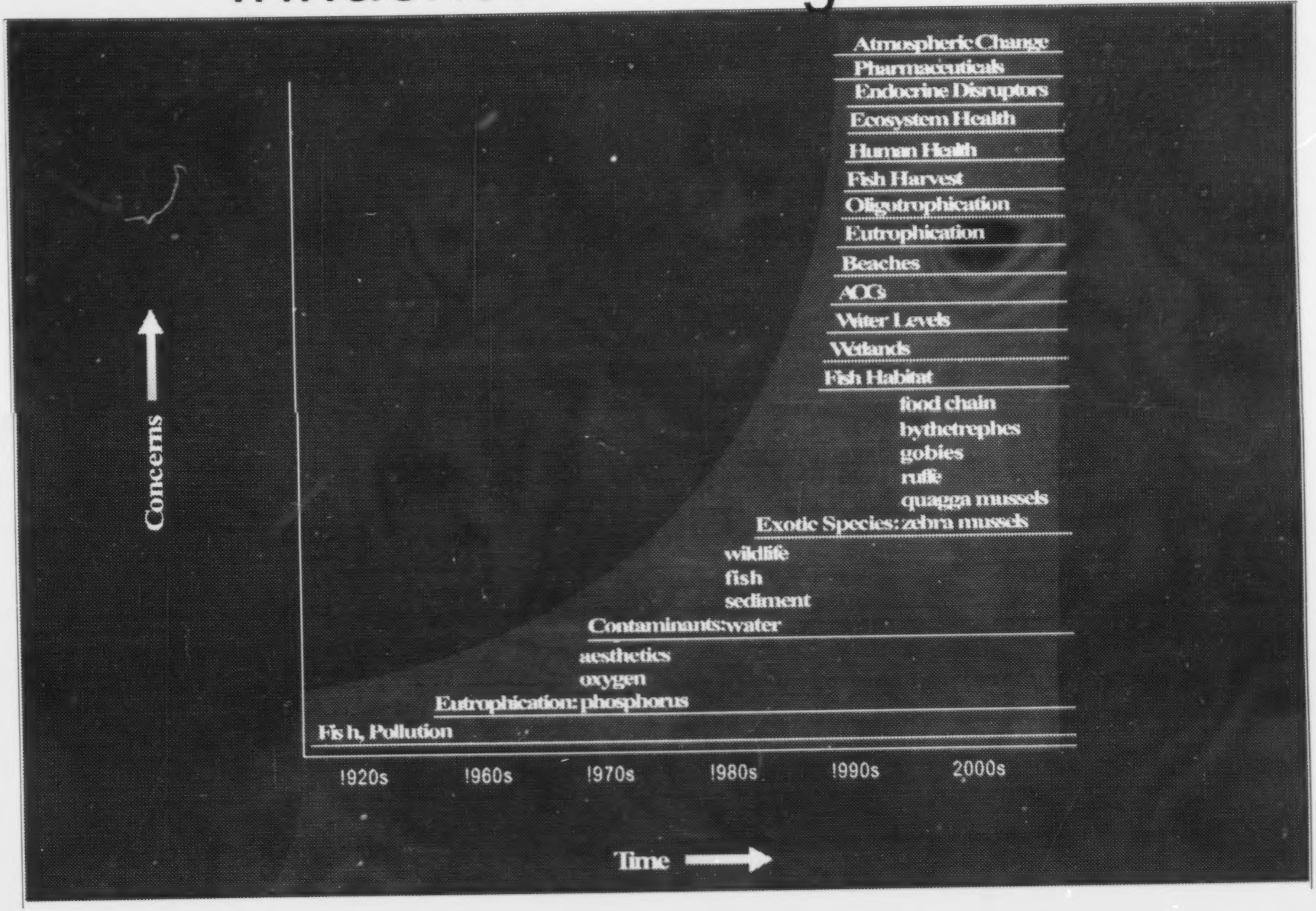
- One third of total Great Lakes population
- Provides drinking water for 11 million people
- Intensive urbanization and agriculture
- Multiple uses

Physical Characteristics

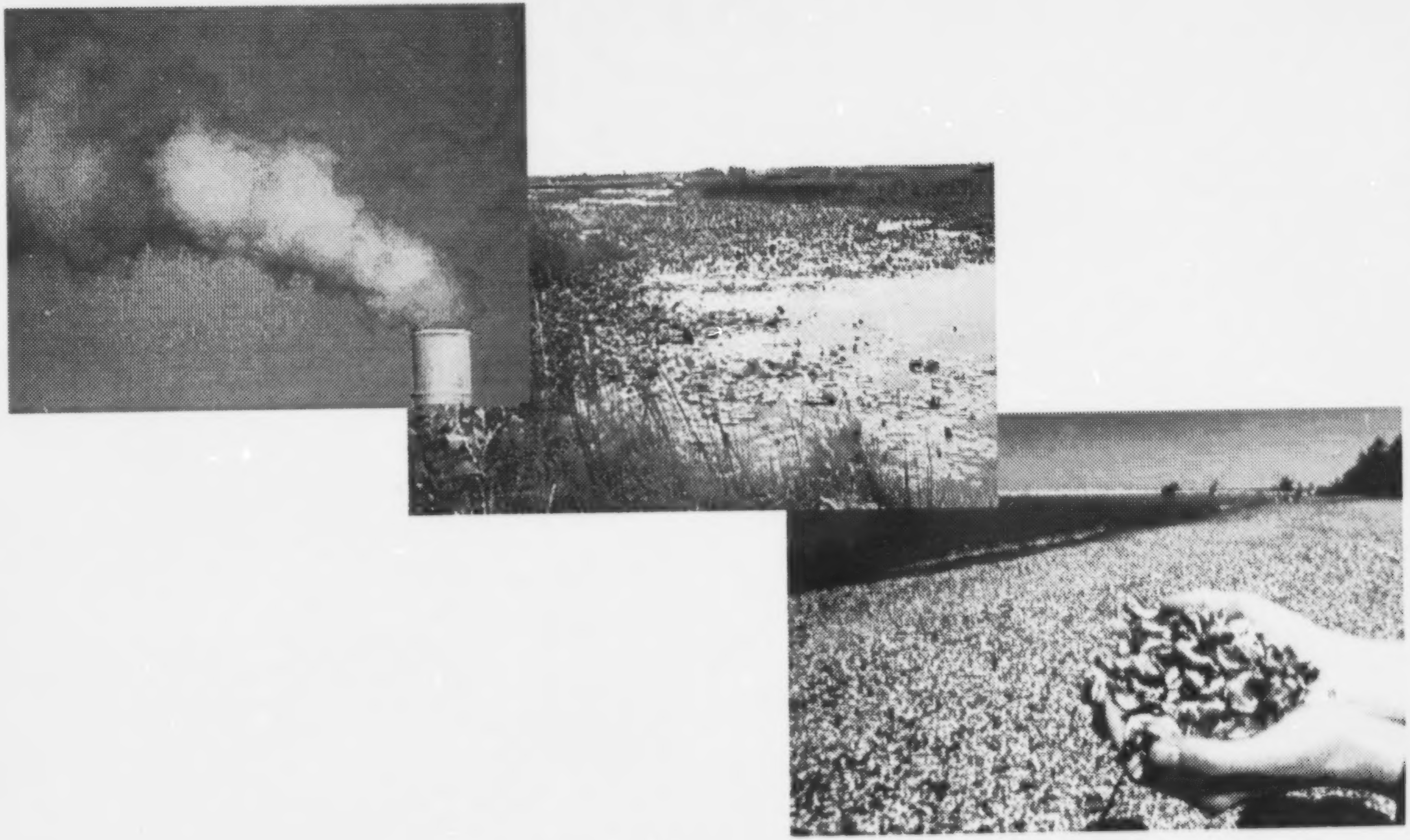
- 3 basins (west/central/east)
- Shallowest, warmest
- Biologically productive
- 80% inflow Detroit River
- Current and wave patterns very complex
- Average retention time = 2.6 years
- Weather- a significant influence

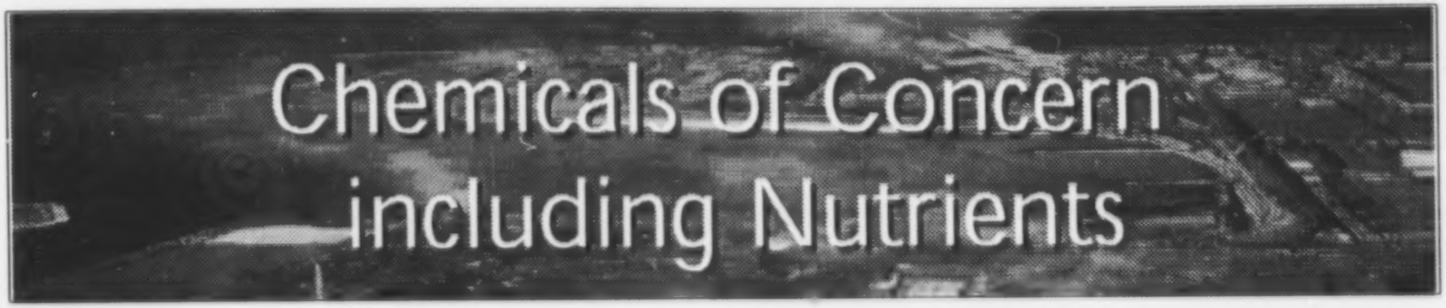

Bathymetry of Lake Erie and Lake Saint Clair
83° 30'W
83° 00'W
82° 30'W
82° 00'W
81° 30'W
81° 00'W
80° 30'W
80° 00'W
79° 30'W
79° 00'W
42° 30'N
42° 00'N
41° 30'N
km
0
50
100
Depth in Meters
0
15
30
45
64

Influences Through Time


Atmospheric Change
Pharmaceuticals
Endocrine Disruptors
Ecosystem Health
Human Health
Fish Harvest
Oligotrophication
Eutrophication
Beaches
AOCs
Water Levels
Wetlands
Fish Habitat
food chain
bythetrephes
gobies
ruffe
quagga mussels
Exotic Species: zebra mussels
wildlife
fish
sediment
Contaminants: water
aesthetics
oxygen
Eutrophication: phosphorus
Fish, Pollution
Concerns
1920s
1960s
1970s
1980s
1990s
2000s
Time

Issues and Concerns





Chemicals of Concern including Nutrients

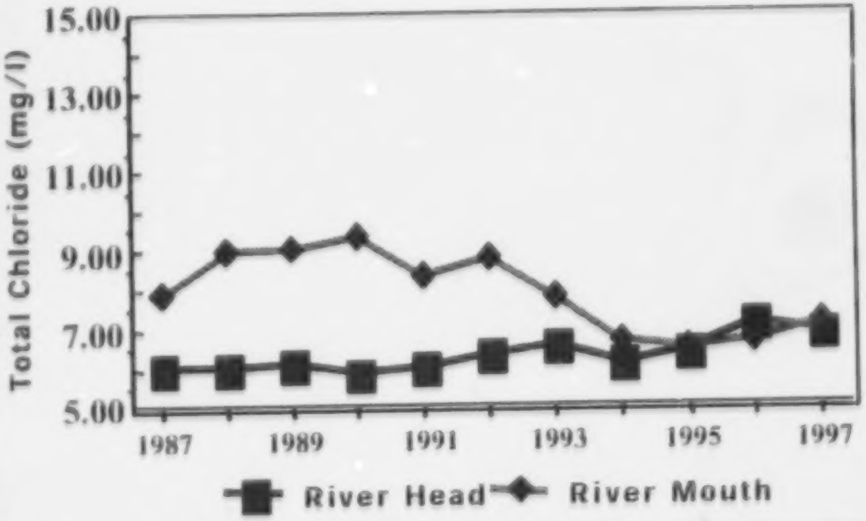
- PCB's*
- Mercury*
- Chlordane
- DDT & metabolites
- Lead
- Dioxins
- Dieldrin
- PAH's
- Phosphorus
- Nitrates
- Agricultural Pesticides
- Endocrine disruptors
- Mixtures

Water Quality Trends

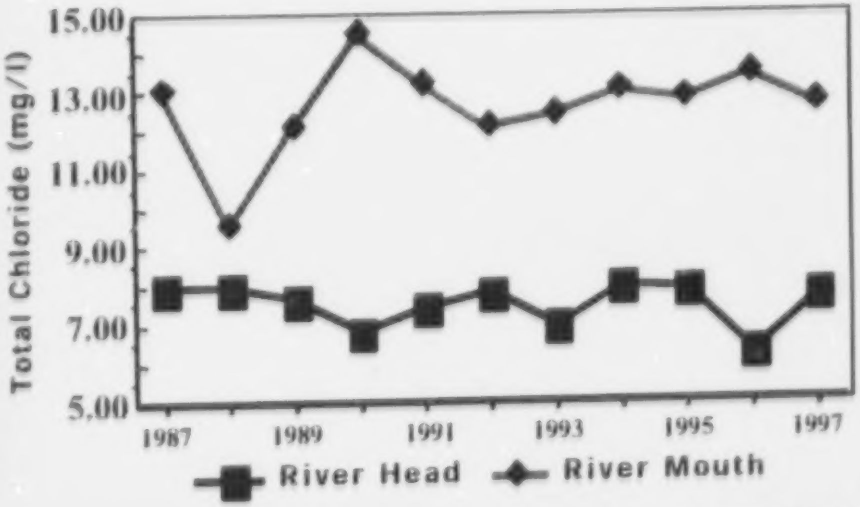
St. Clair River
Lake St. Clair
Detroit River

St. Clair RAP Yardstick = 50 mg/l

St. Clair River - Chloride



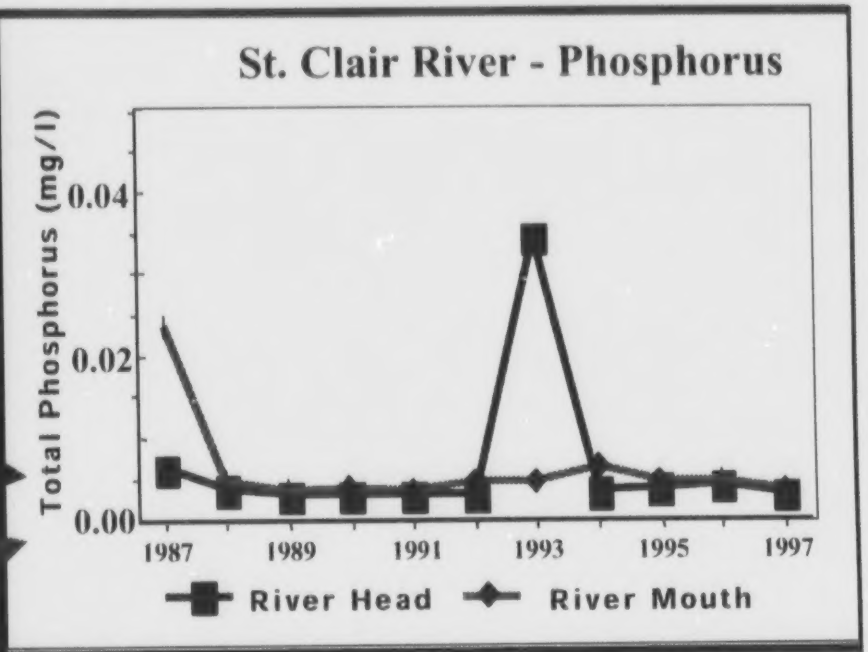
Detroit River - Chloride

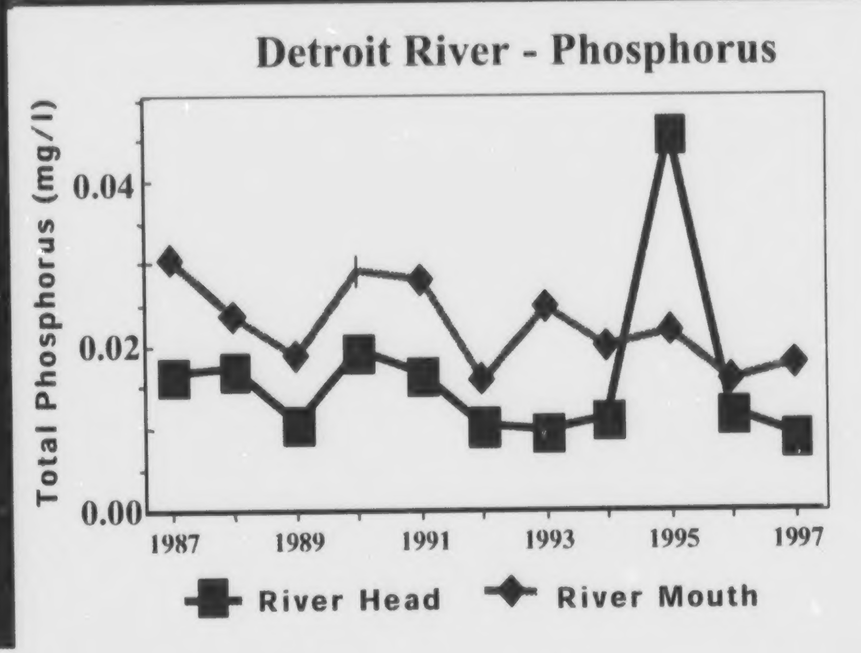


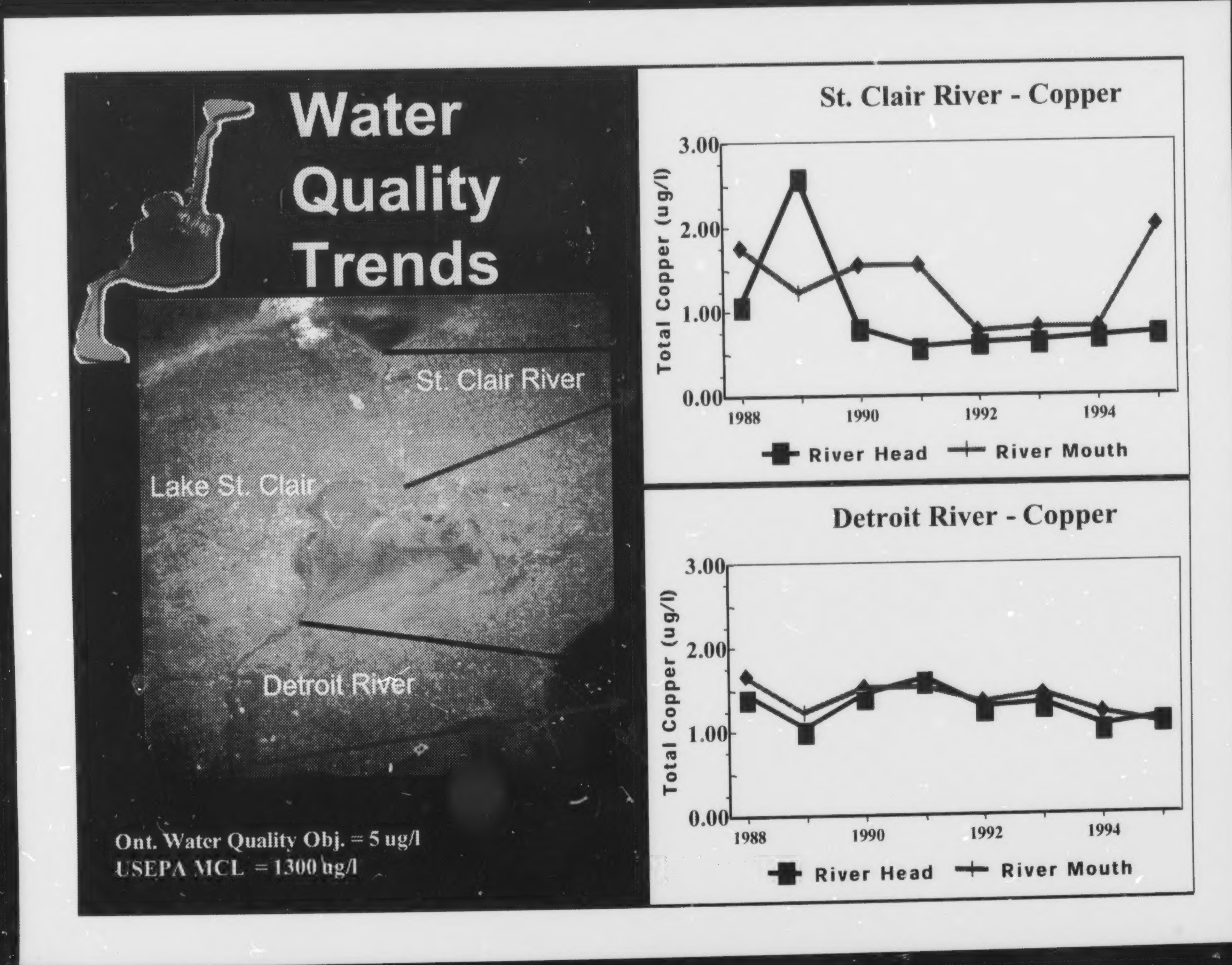
Water Quality Trends

St. Clair River
Lake St. Clair
Detroit River

St. Clair RAP Yardstick = 20 mg/l







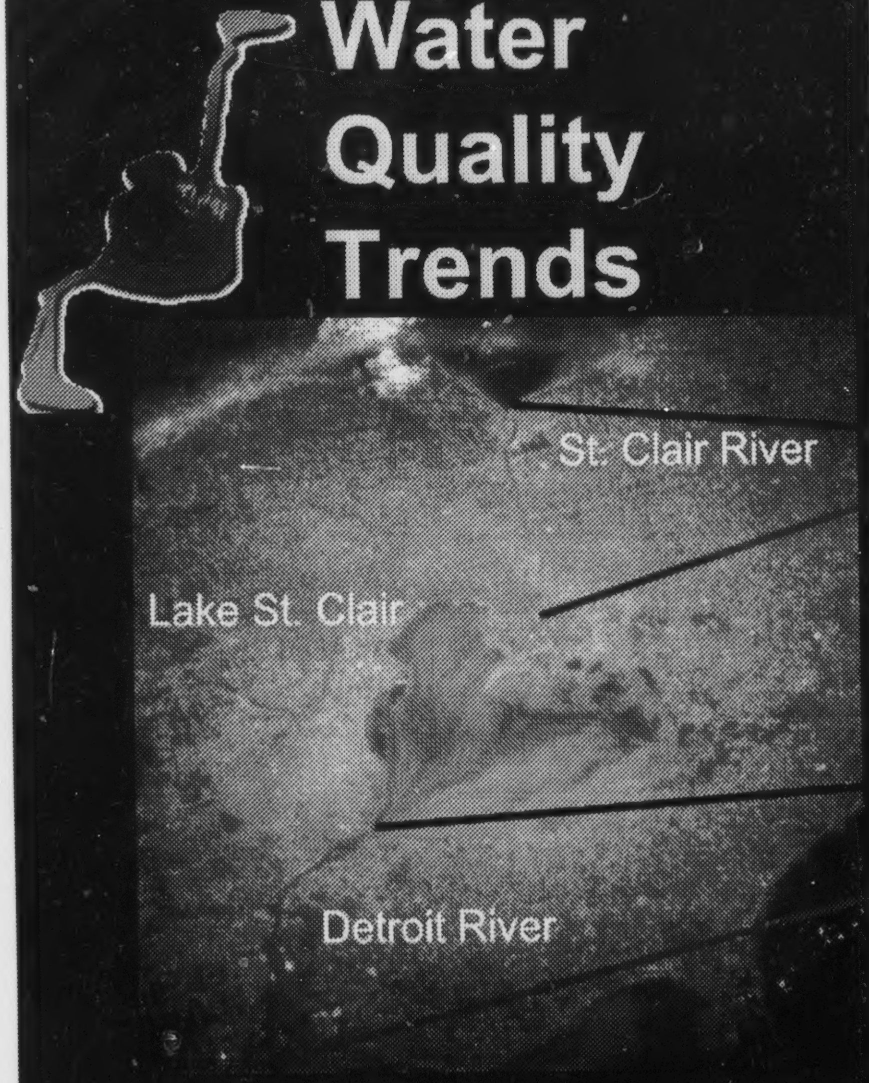
Water Quality Trends

Ont. Water Quality Obj. = 5 ug/l
USEPA MCL = 1300 ug/l

St. Clair River - Copper

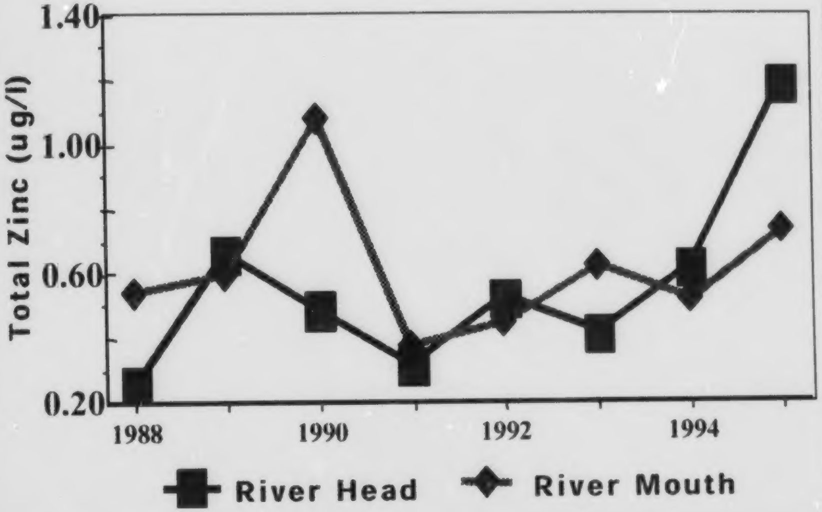
Detroit River - Copper

Water Quality Trends

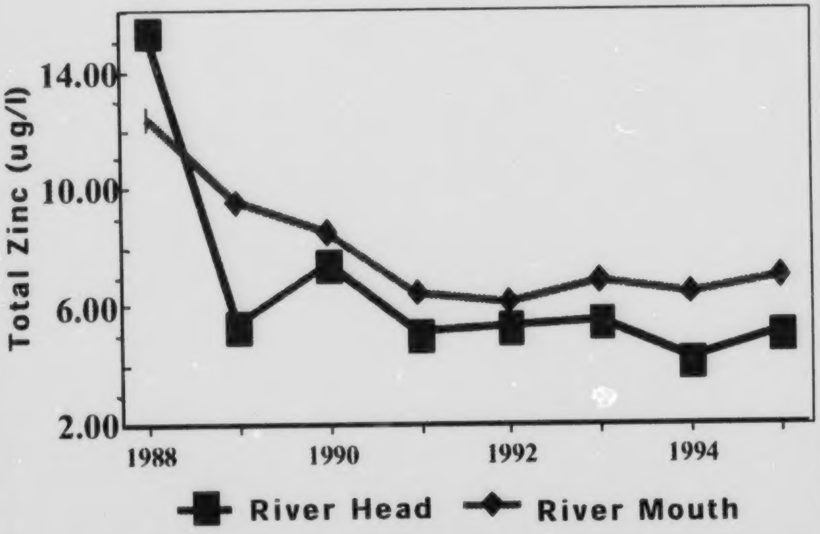

St. Clair River
Lake St. Clair
Detroit River

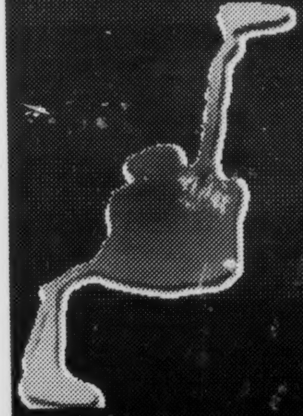
MI Water Quality Std. = 49 ug/l
Ontaro Water Quality Obj. = 30 ug/l

St. Clair River - Zinc

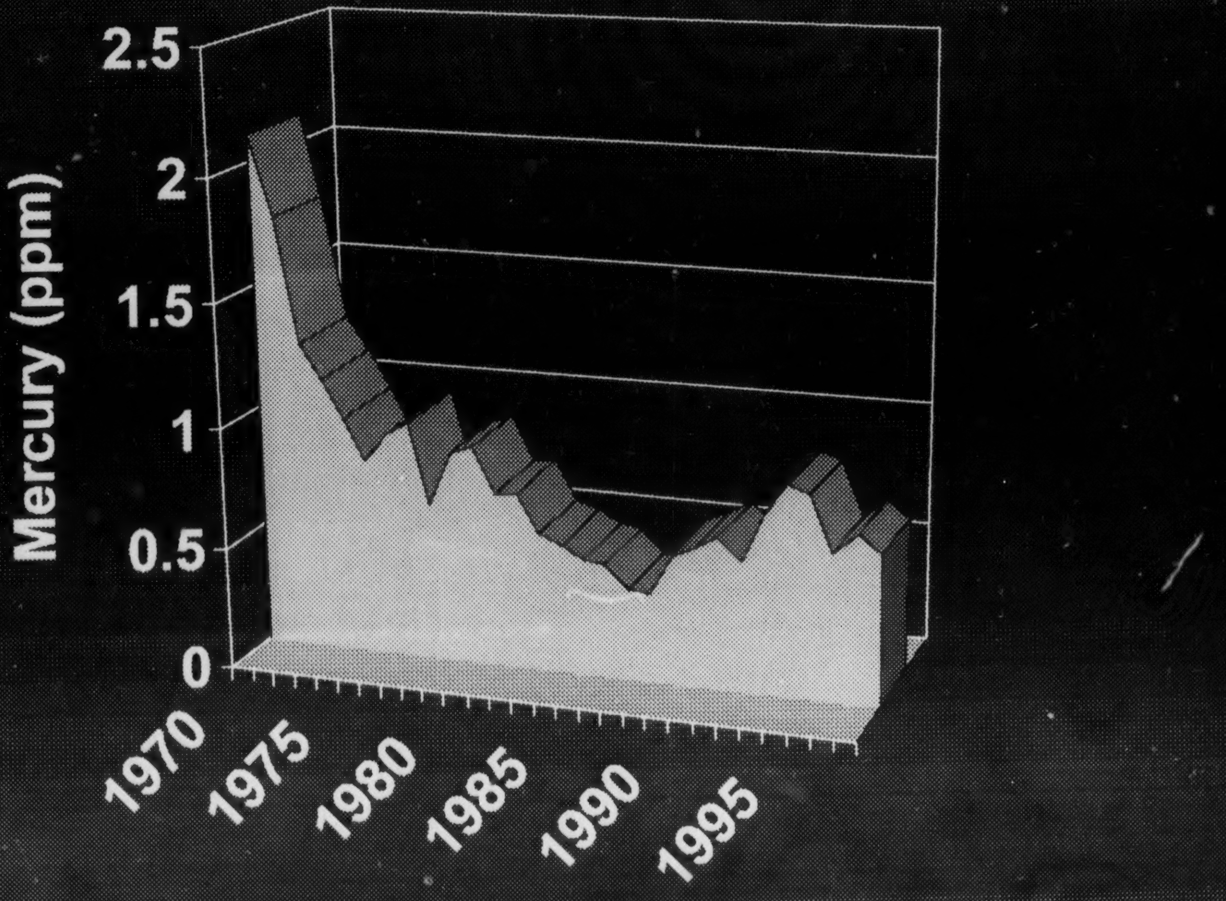


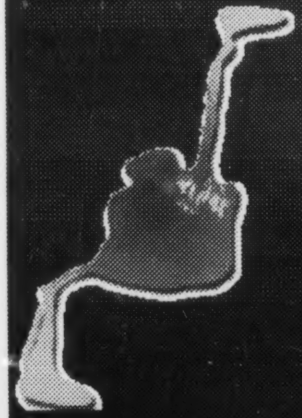
Detroit River - Zinc



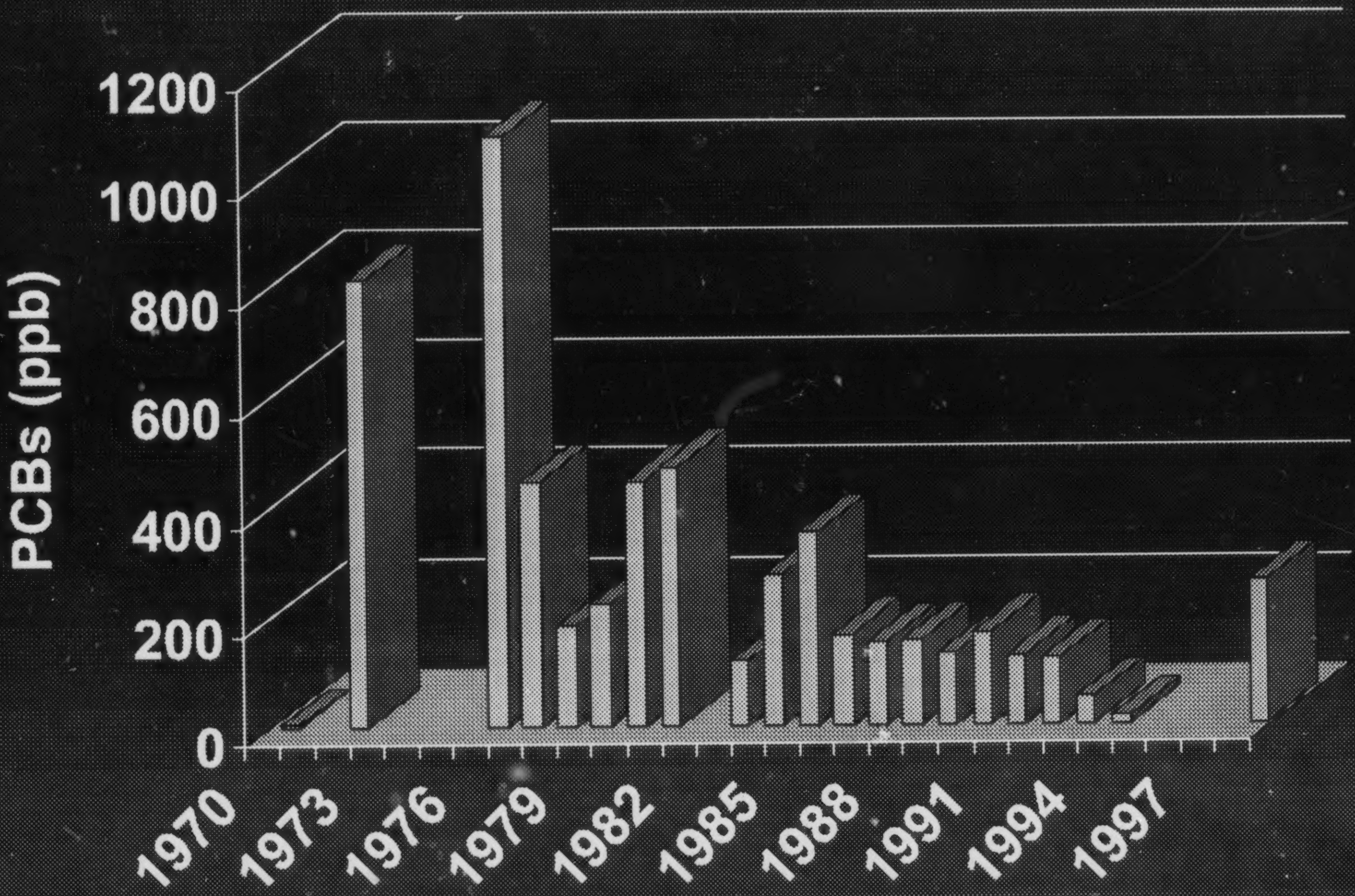


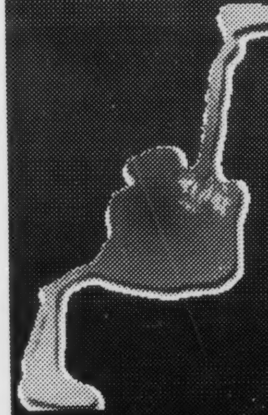
Mercury in Lake St. Clair Walleye (ppm) - edible portion



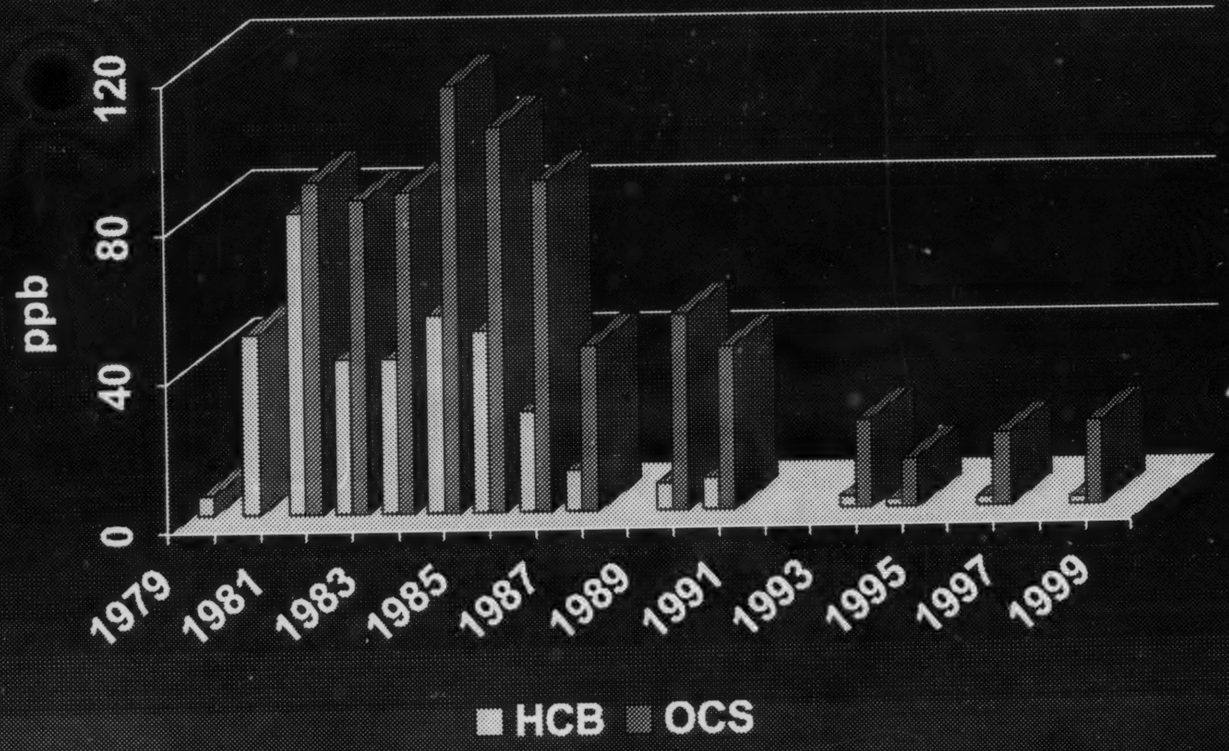


PCBs in Lake St. Clair Walleye (ppb) - edible portion



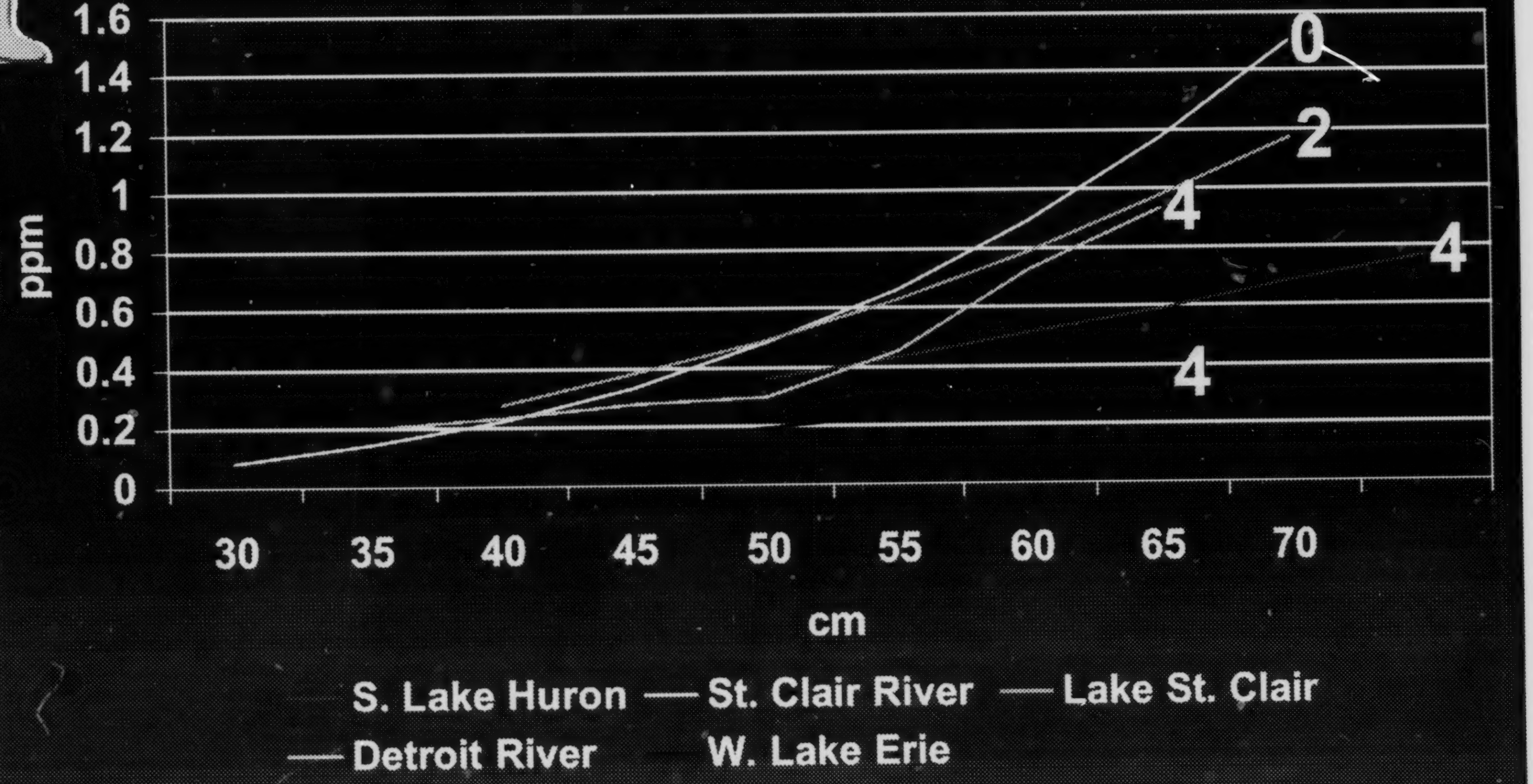


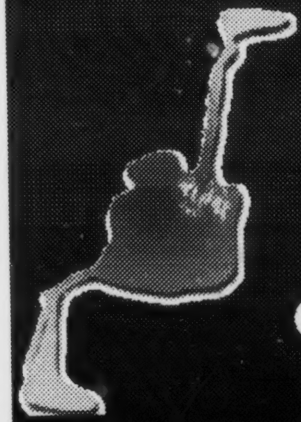
HCB and OCS in Lake St. Clair Channel Catfish



Mercury vs. Walleye length
1998

Indicator 4083: Contaminants in Edible Fish Tissue





Importance of Sportfishing in Corridor

- 200 marinas and 150,000 Mi. boats adjacent to Lake St. Clair; Annual value of ~$260M
- 1.5M fish taken from Lake St. Clair annually;
- LSC accounts for nearly half of entire Great Lakes sport fishing effort.
- Majority of anglers eat their catch

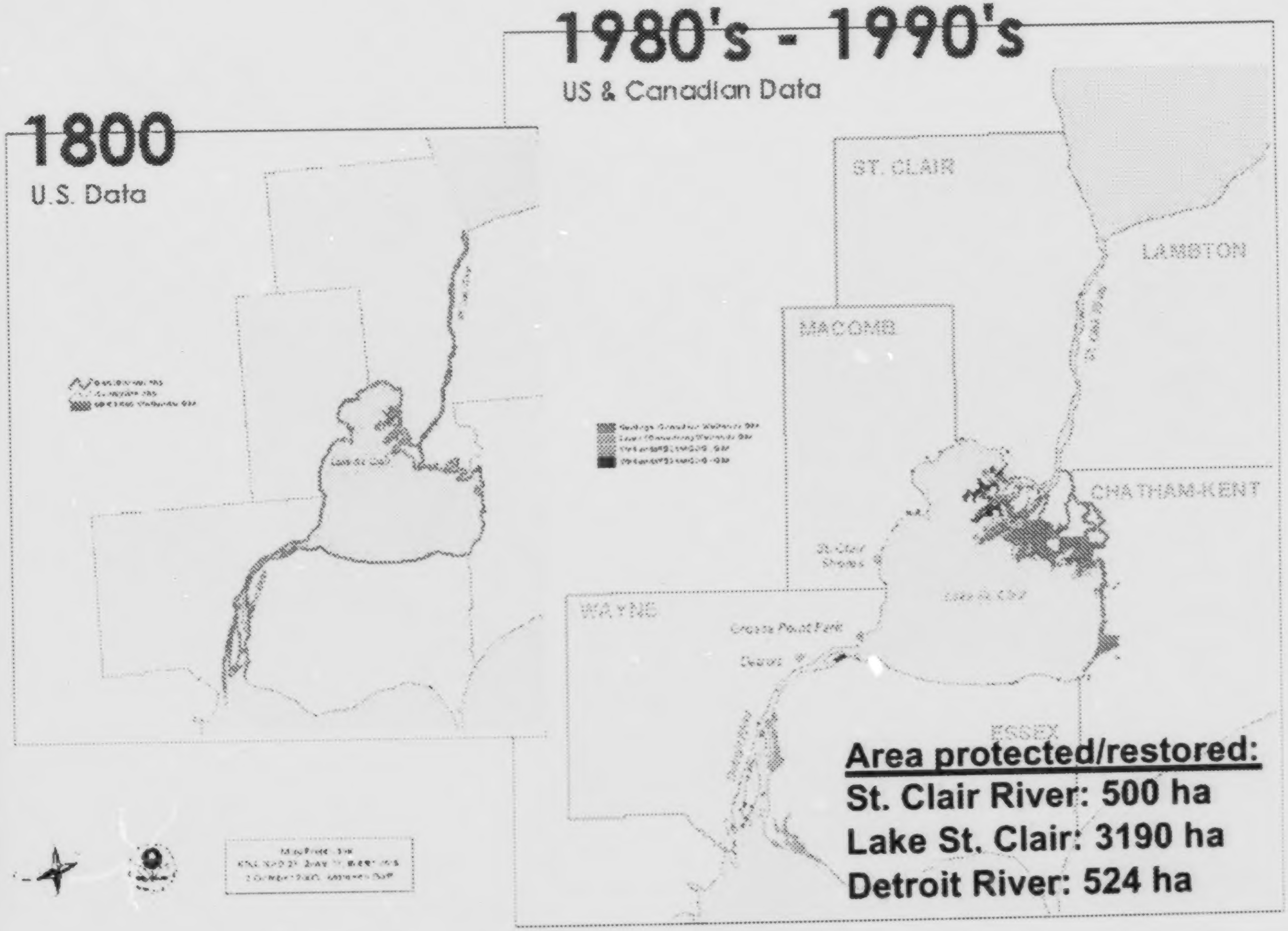
State of Coastal wetlands

Indicators # 4510 and 4511: *Gain in restored* Coastal Wetland area by type

An indicator of periodic changes and the success of conservation and rehabilitation efforts

Wetland losses 1800 - 1990

Huron-Erie Corridor Near-Shore Wetlands



1800

U.S. Data

1980's - 1990's

US & Canadian Data

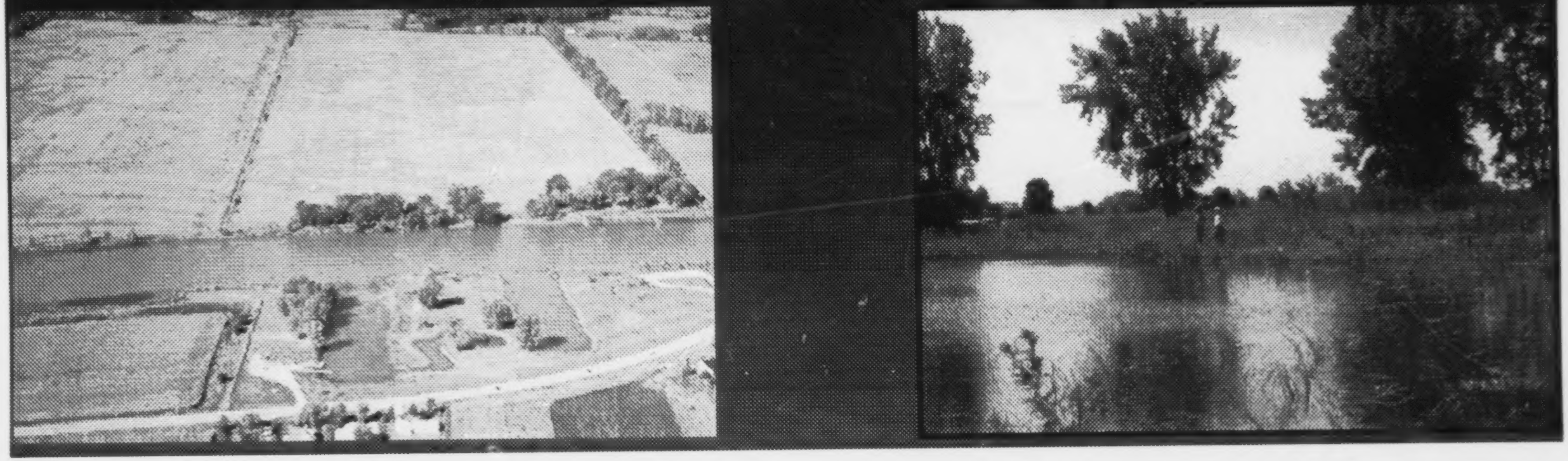
ST. CLAIR
LAMBTON
MACOMB
CHATHAM-KENT
WAYNE
ESSEX
St. Clair Shores
Grosse Pointe Park
Detroit

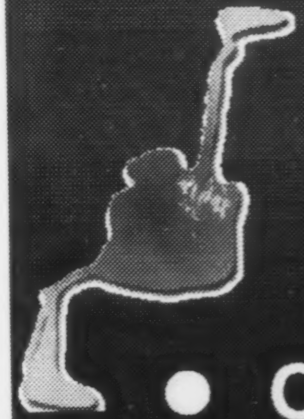
Area protected/restored:

- St. Clair River: 500 ha
- Lake St. Clair: 3190 ha
- Detroit River: 524 ha

Pressures on the system

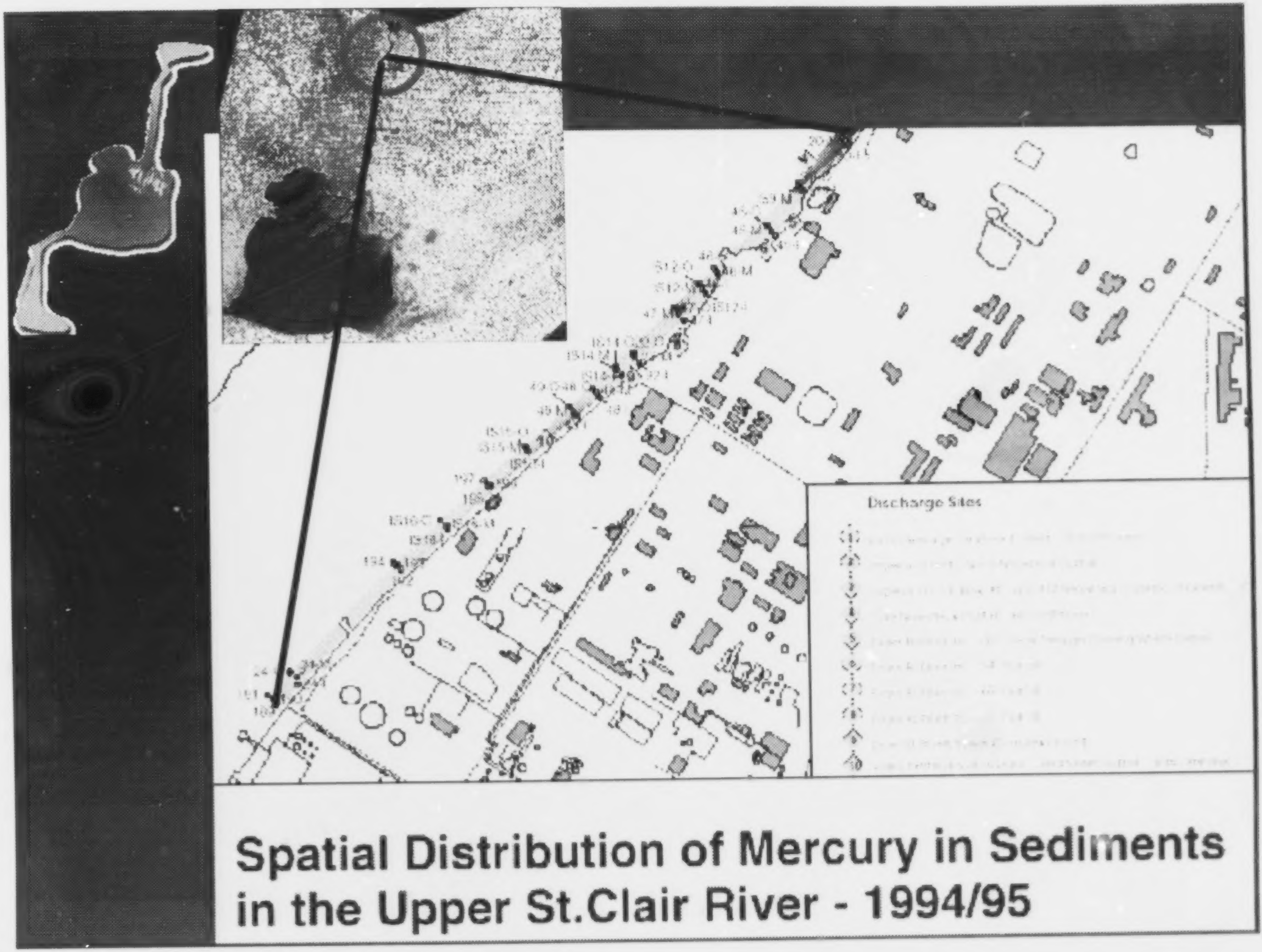
- Loss of fish and wildlife habitat is a primary and consistent concern throughout the Corridor



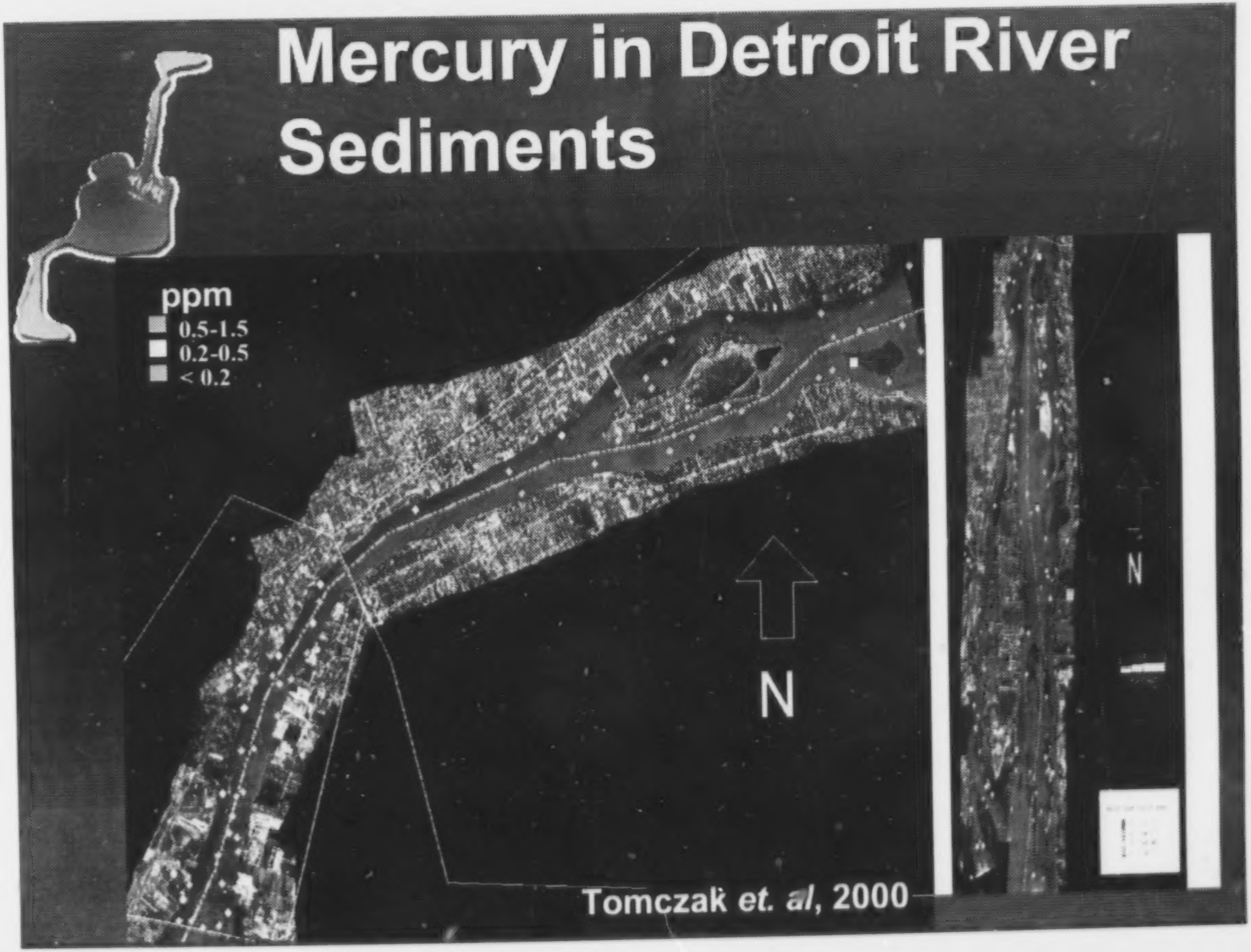


Activities to mitigate pressures

- Ongoing efforts to acquire critical habitat;
- Shoreline enhancement projects;
- Biodiversity conservation strategy and atlas;
- CWS conservation targets
- Candidate sites;
- Protection of designated wetlands


Discharge Sites

Spatial Distribution of Mercury in Sediments in the Upper St.Clair River - 1994/95

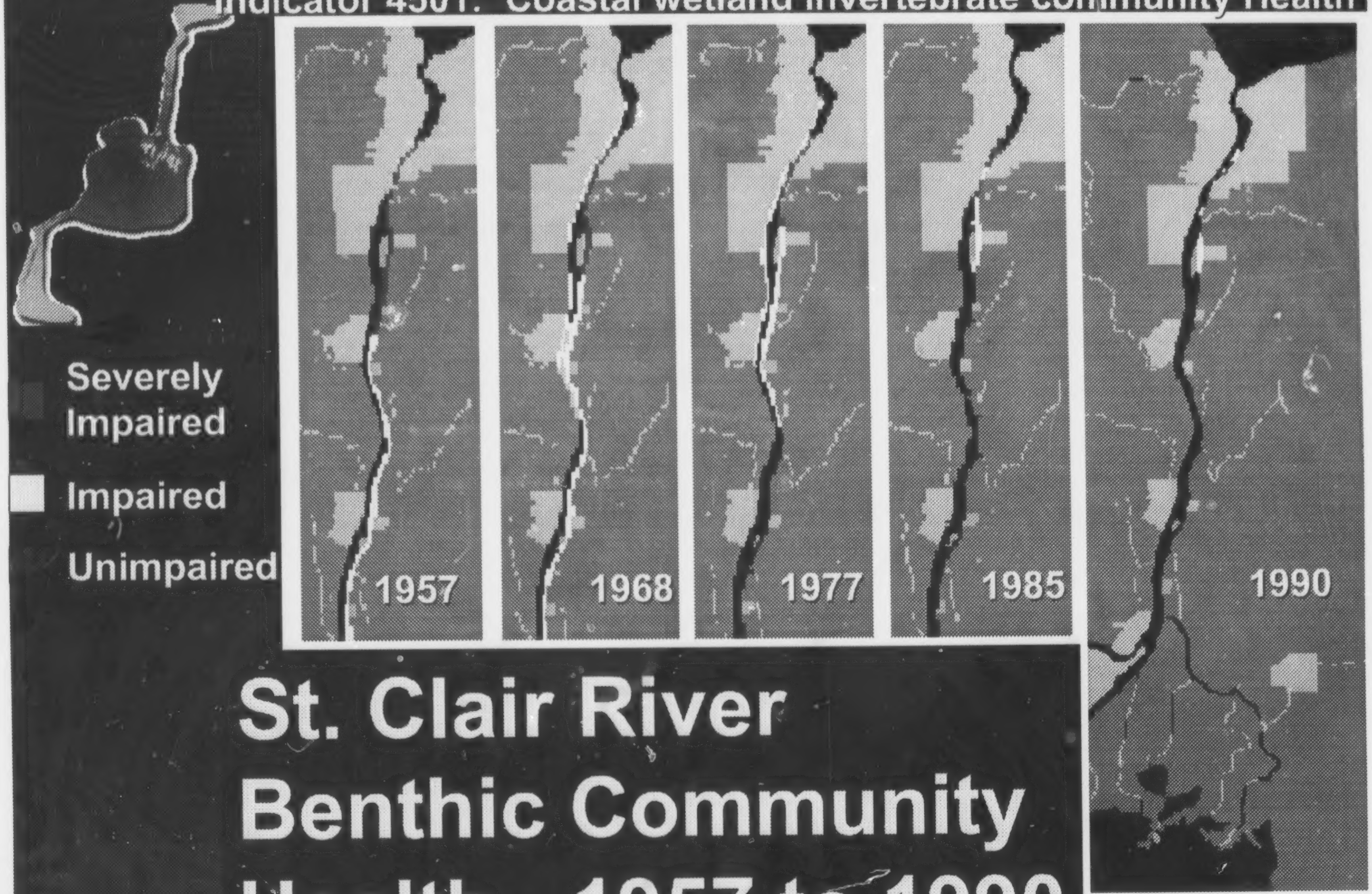


Mercury in Detroit River Sediments

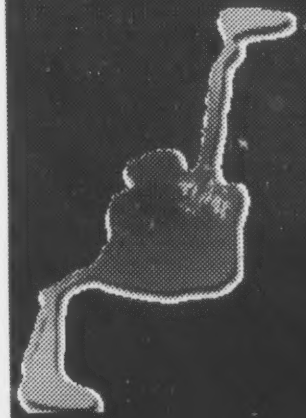
ppm
▨ 0.5-1.5
□ 0.2-0.5
▨ < 0.2
N
N

Tomczak et. al, 2000

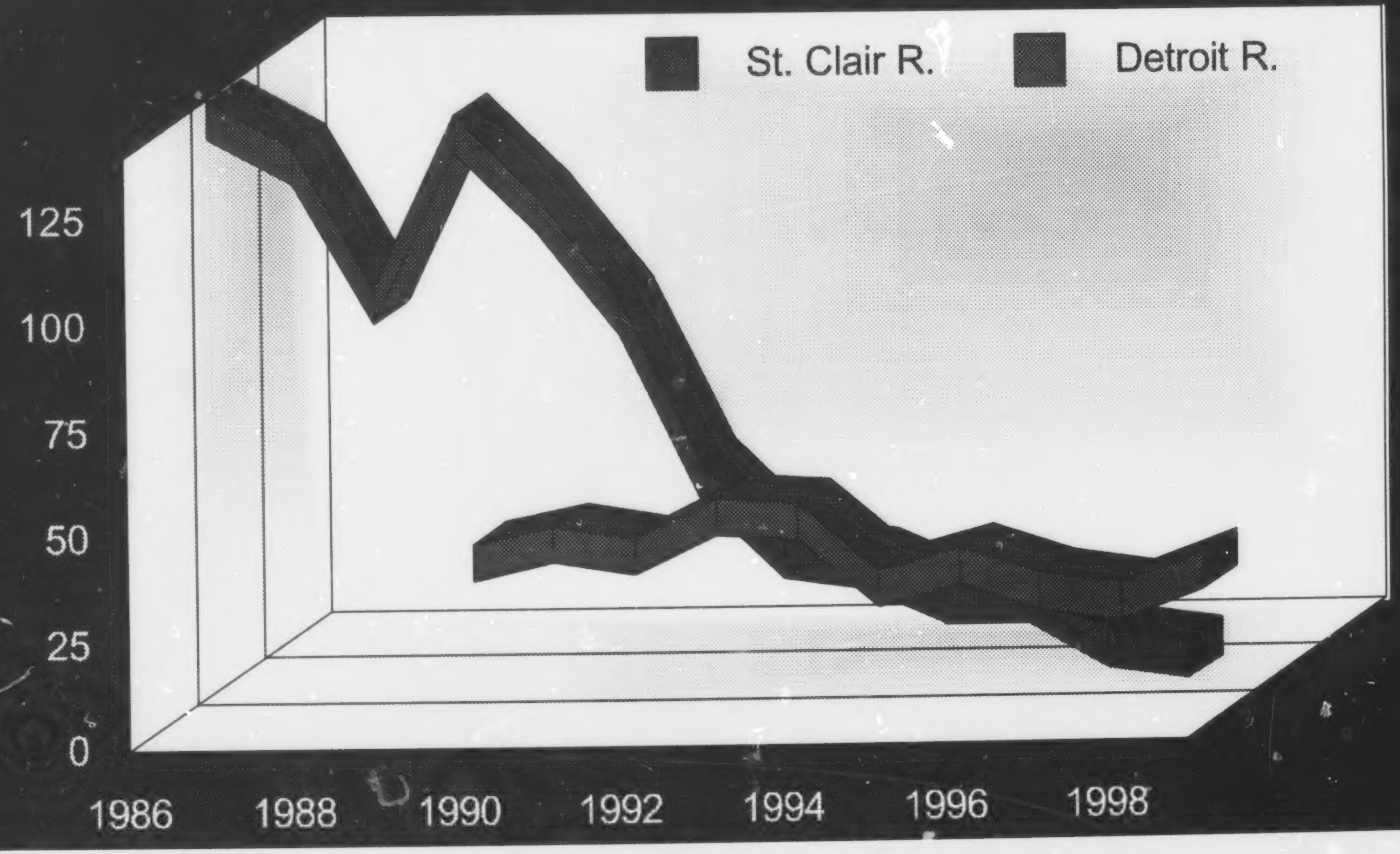
Indicator 4501: Coastal wetland Invertebrate community Health


Severely Impaired
Impaired
Unimpaired
1957
1968
1977
1985
1990

St. Clair River Benthic Community Health - 1957 to 1990

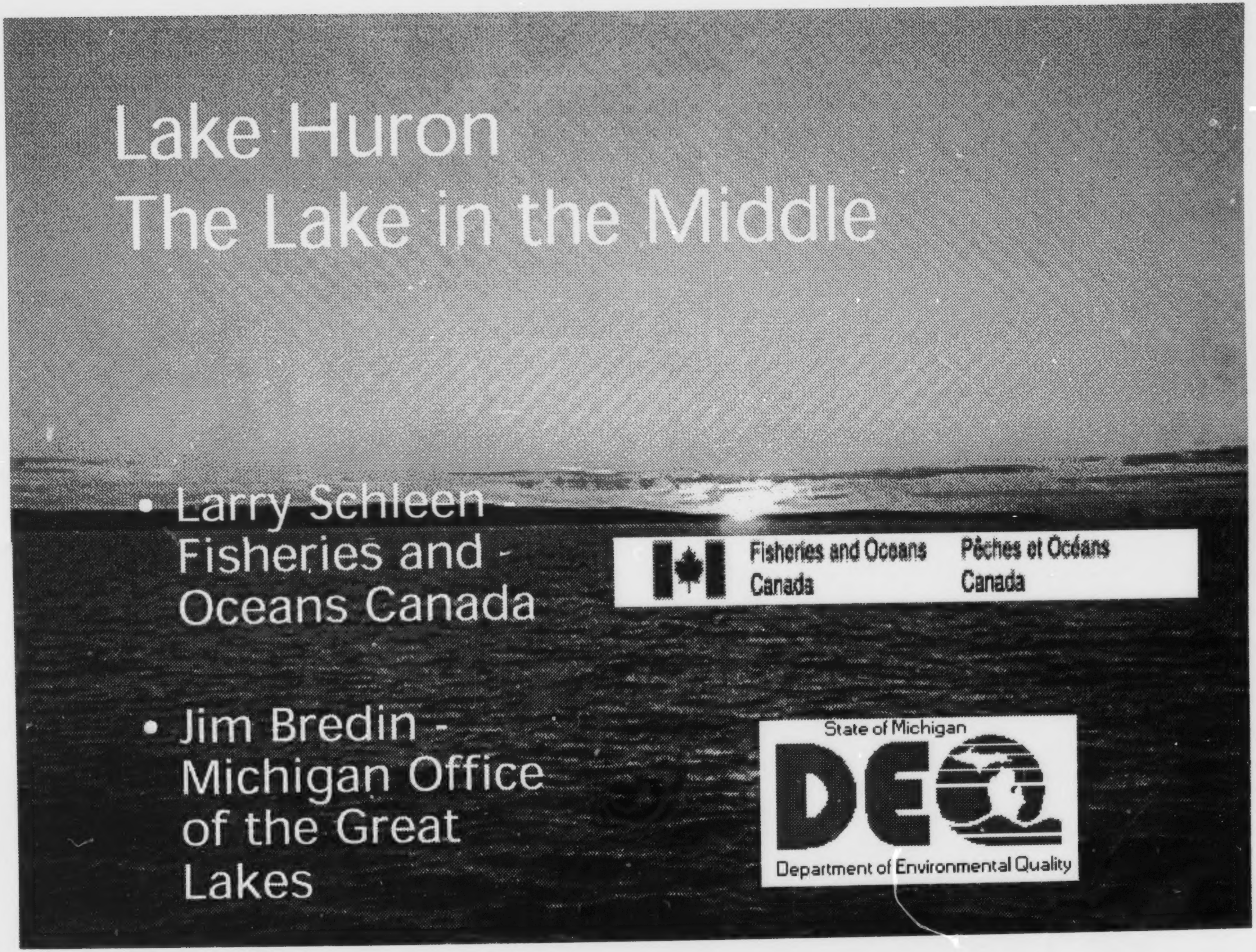


Spills to the St. Clair and Detroit Rivers



Conclusions and Emerging Issues

- Area is important ecologically and commercially;
- Effective source controls, need to manage historical contamination;
- Habitat protection/restoration - focus on incremental gains;
- Need ongoing monitoring to ensure continuous improvement



Lake Huron
The Lake in the Middle

- Larry Schleen - Fisheries and Oceans Canada
- Jim Bredin - Michigan Office of the Great Lakes

Fisheries and Oceans Canada
Pêches et Océans Canada

State of Michigan
DEQ
Department of Environmental Quality

Lake Huron

From the sandy eastern
shores of Michigan, USA...

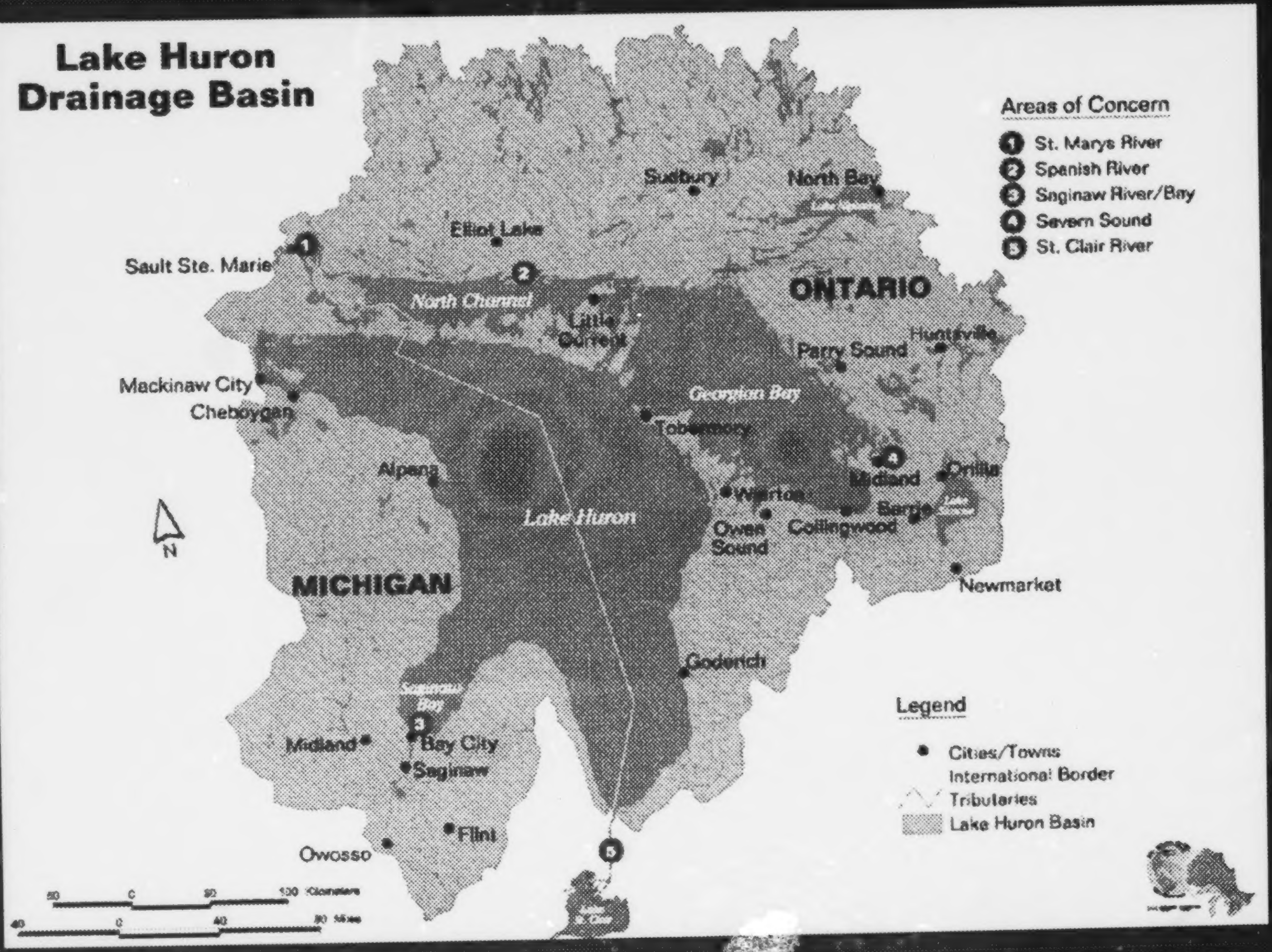
Lake Huron

...to the rocky shores of northern Georgian Bay, Canada

Courtesy of Georgian Bay Association

Lake Huron

....more islands than any other lake in the world, the largest island, Manitoulin, of any freshwater lake and the longest lakeshore when the 30,000-plus islands are included

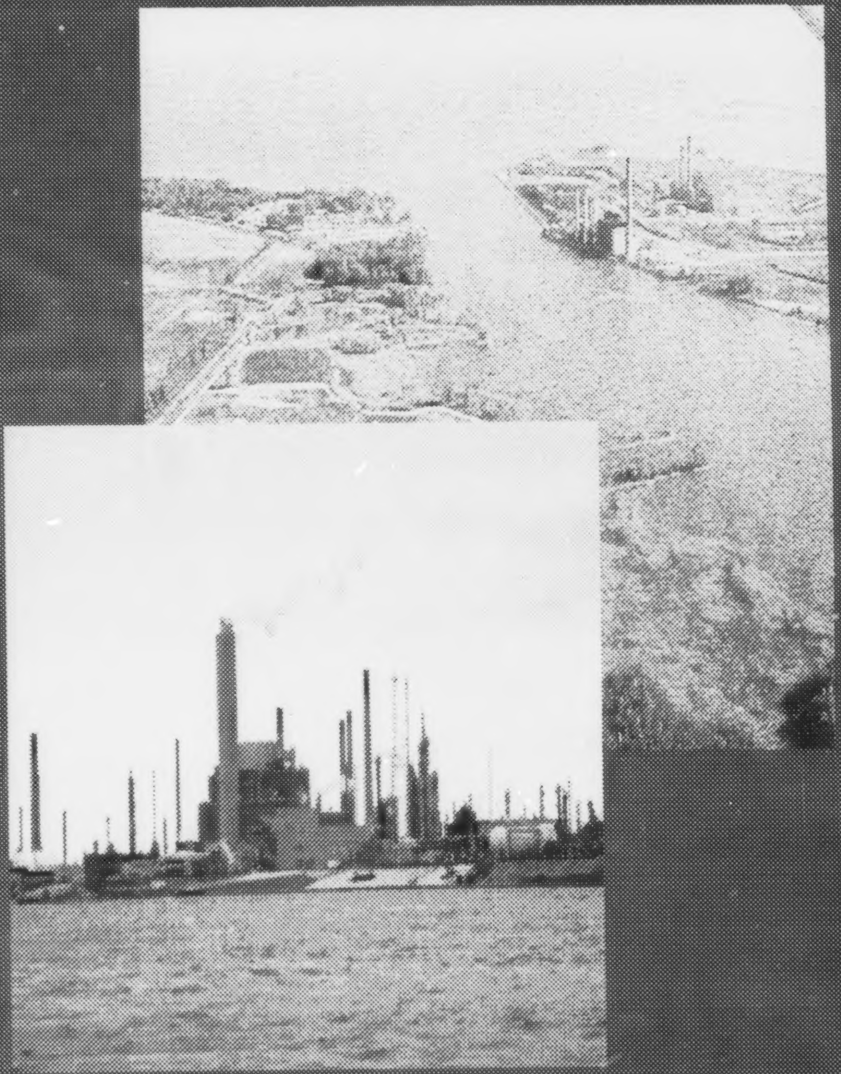


Lake Huron
Drainage Basin
Areas of Concern
1 St. Marys River
2 Spanish River
3 Saginaw River/Bay
4 Severn Sound
5 St. Clair River
Sudbury
North Bay
Elliot Lake
Sault Ste. Marie
North Channel
Little Current
ONTARIO
Parry Sound
Huntsville
Mackinaw City
Cheboygan
Georgian Bay
Tobermory
Alpena
Midland
Orillia
Wiarton
Barrie
Owen Sound
Collingwood
Lake Huron
N
Newmarket
MICHIGAN
Goderich
Saginaw Bay
Legend
Midland
Bay City
Saginaw
● Cities/Towns
International Border
Tributaries
Lake Huron Basin
Flint
Owosso
50 0 50 100 Kilometers
40 0 40 80 Miles

Prepared by: Environment Canada - Atmospheric Environment Branch, Geomatics Unit

Lake Huron

Historical discharges have have caused serious problems in a number of areas within the basin.



Lake Huron

- 2.5 million people, most in southern portion of basin
- Increasing pressure for seasonal land uses, threatening wildlife habitat and unique ecosystems

Lake Huron

- Low degree of industrialization, except Saginaw Bay area and Sarnia
- Saginaw Bay still supports some of the most extensive coastal habitat in the Great Lakes

Lake Huron - The Details

- Threat of critical pollutants to human health and wildlife
- Sources of critical pollutants, recommended actions
- Remaining habitat resources
- Sources of stress to the habitat, recommended actions
- Recent successes and needed actions

Impaired Uses

- Restrictions on fish or wildlife consumption caused by high concentrations of critical pollutants
- Degradation of fish and wildlife populations caused by non-native species, sedimentation and loss habitat
- Loss of fish or wildlife habitat caused by loss of wetlands and high gradient streams, and increased sedimentation

Critical Pollutants

Critical pollutant has been identified and include:

PCBs
Chlordane
Dioxins
Mercury
Sediment/ Suspended Solids
DDT

Contaminant Trends

- Contaminant concentrations are relatively low

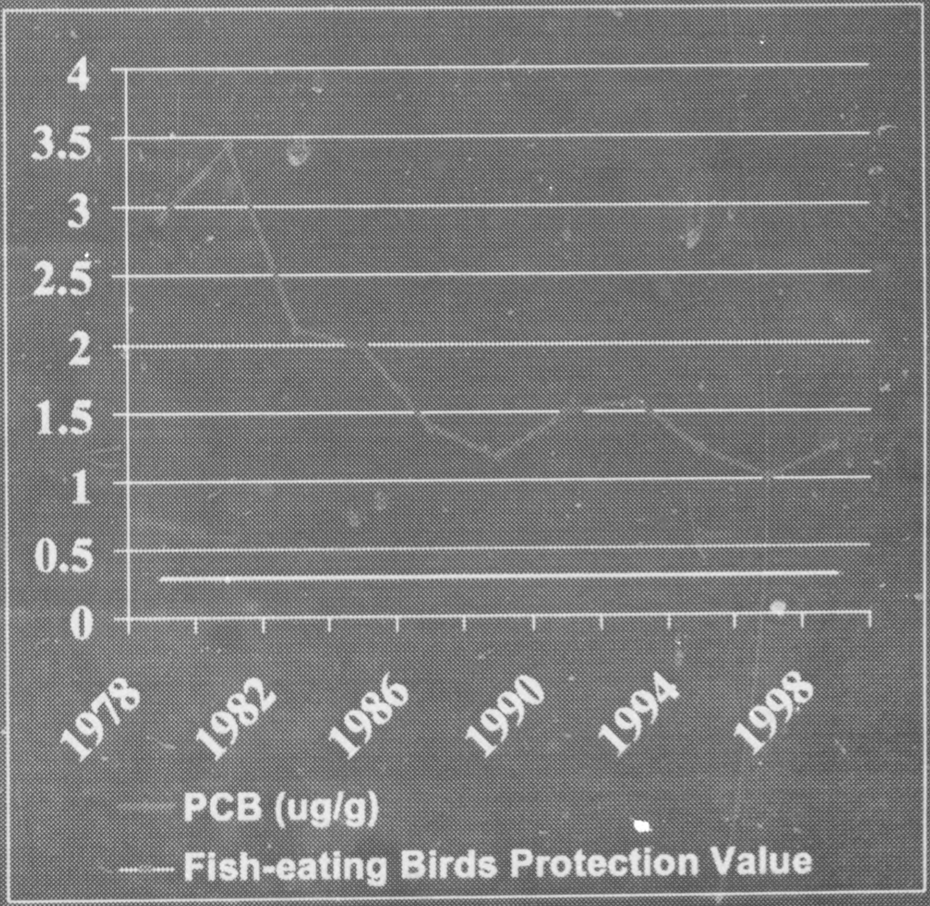
- Public health advisories exist regarding fish consumption

Fish Consumption Advisories

- PCBs
- Chlordane
- Dioxins
- Mercury
- DDT/ PBBs
- Toxaphene

Contaminant Trends

- Concentrations declined significantly in lake trout (whole fish)
- Still above the protection values for fish-eating birds and mammals



Contaminant Trends

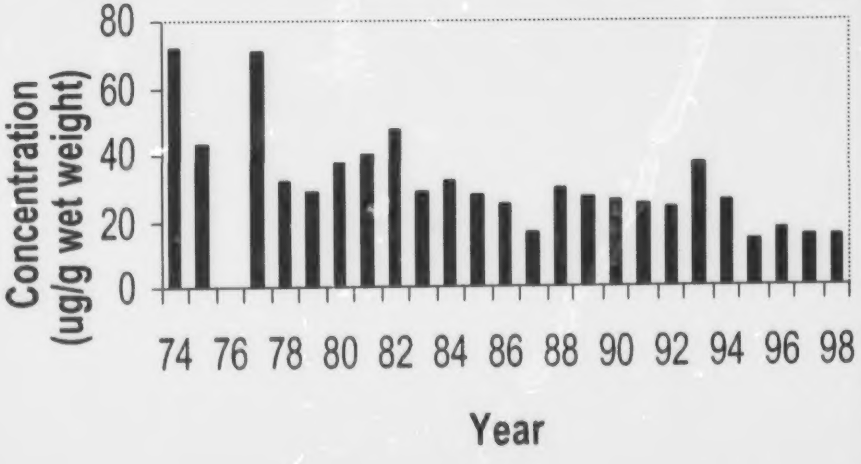
- PCB - no significant decline since the mid 1980s
- Continuing sources: historical discharges, air deposition

Contaminant Trends

Fish	Long-term	Recent
DDT	↓	↓
PCB	↓	No change
Dieldrin	↓	
Dioxins	↓	
Mercury	↓	No change

Contaminant Trends: Fish Eating Birds

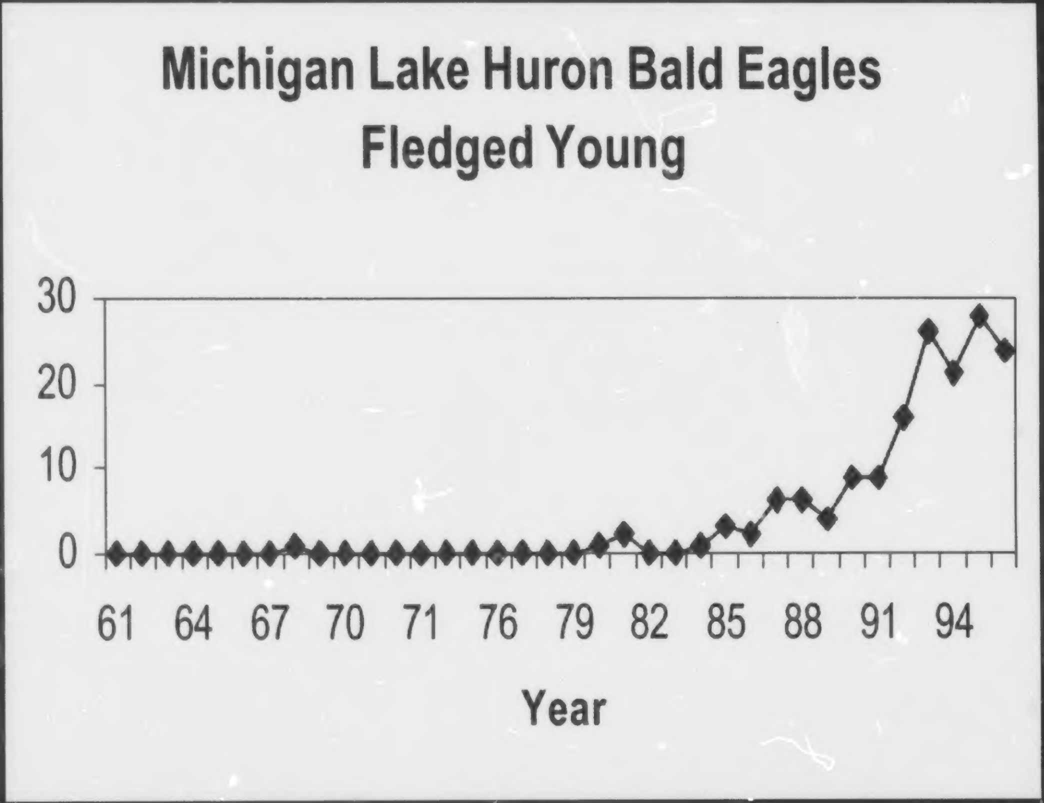
- Rate of decrease has slowed
- Most populations have become re-established
- Problems continue



PCBs in Herring Gull Eggs

Contaminant Trends

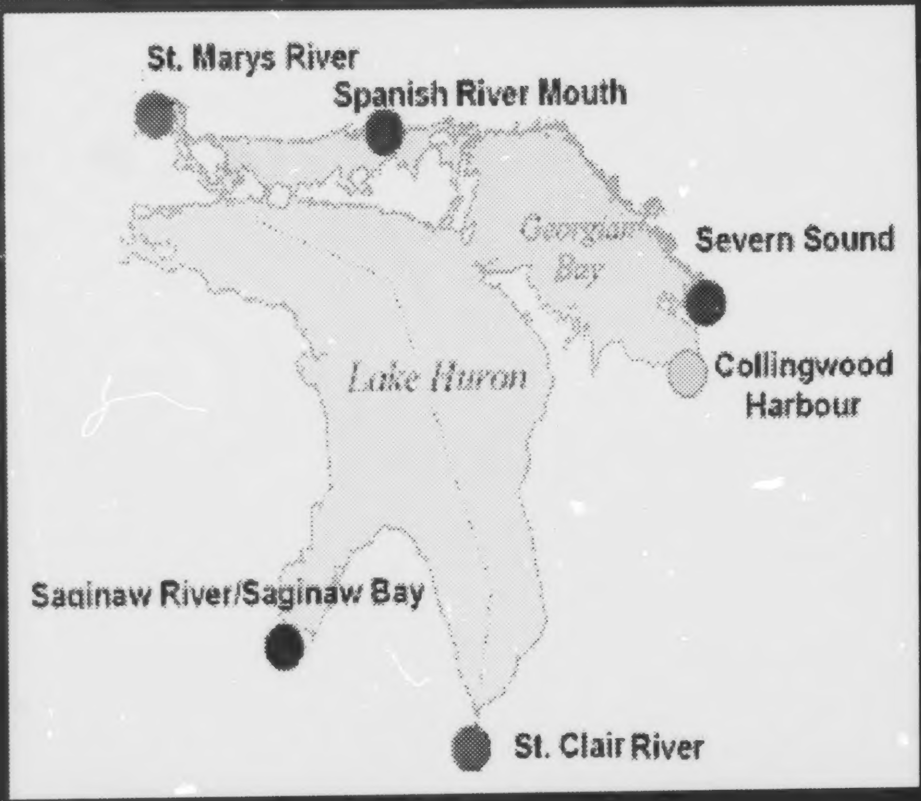
- Eagle population continues to grow
- Interior breeding areas have greater productivity



Michigan Lake Huron Bald Eagles
Fledged Young

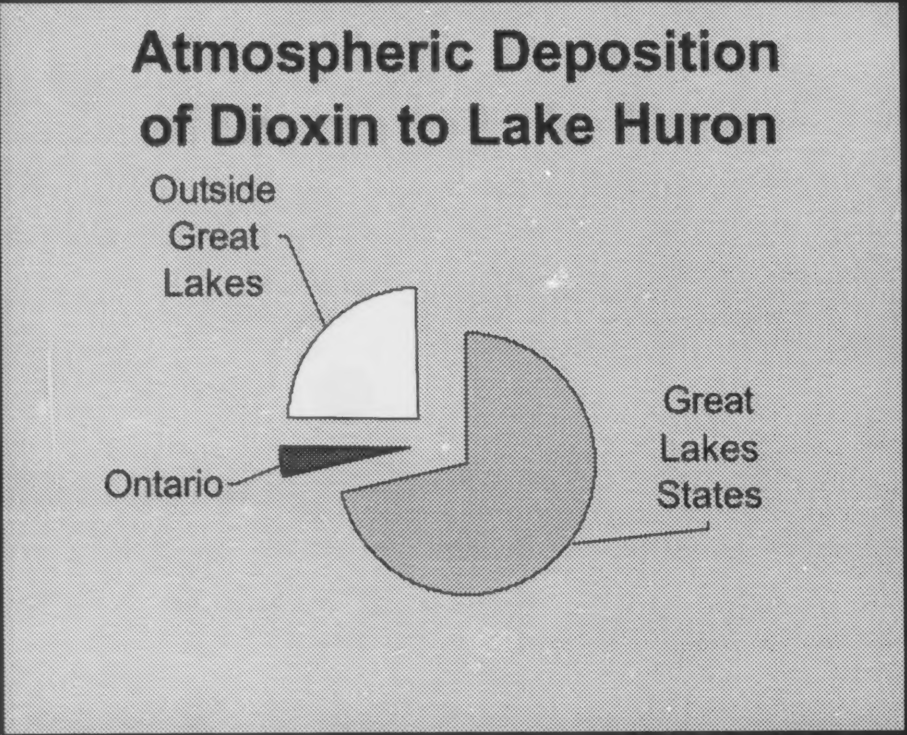
Areas of Concern

- Collingwood Harbour (delisted)
- Spanish River
- Severn Sound
- Saginaw River/Saginaw Bay
- St. Marys River
- St. Clair River


St. Marys River
Spanish River Mouth
Georgian Bay
Severn Sound
Lake Huron
Collingwood Harbour
Saginaw River/Saginaw Bay
St. Clair River

Contaminant Sources

- Loadings from water sources are the lowest of the Great Lakes
- Air sources are highest
- 80-90% of Dioxins are from atmospheric sources



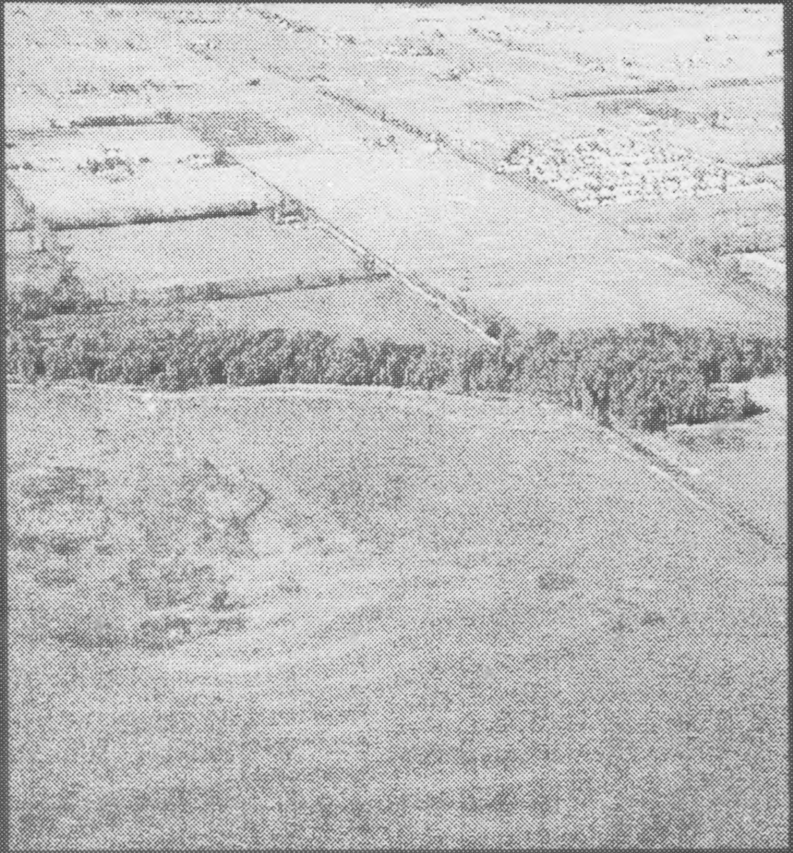
Atmospheric Deposition of Dioxin to Lake Huron

Addressing Critical Pollutants

- Few sources of pollutants within the basin compared to other Great Lakes
- Need to address Areas of Concern, especially contaminated sediments
- Out-of-basin efforts required to address atmospheric deposition

Nearshore Areas

- Nearshore terrestrial ecosystems sustain an amazing diversity of wildlife



Courtesy of Ducks Unlimited

Nearshore Areas

- The nearshore area habitats at one time, encircled the lake
- Where these remain, they are an important resource for fish and wildlife

Courtesy of Lake Huron Centre for Coastal Conservation

Coastal Wetlands

- The diversity of wetland types contribute the complexity of the habitat
- Local conditions create niches for a diverse community

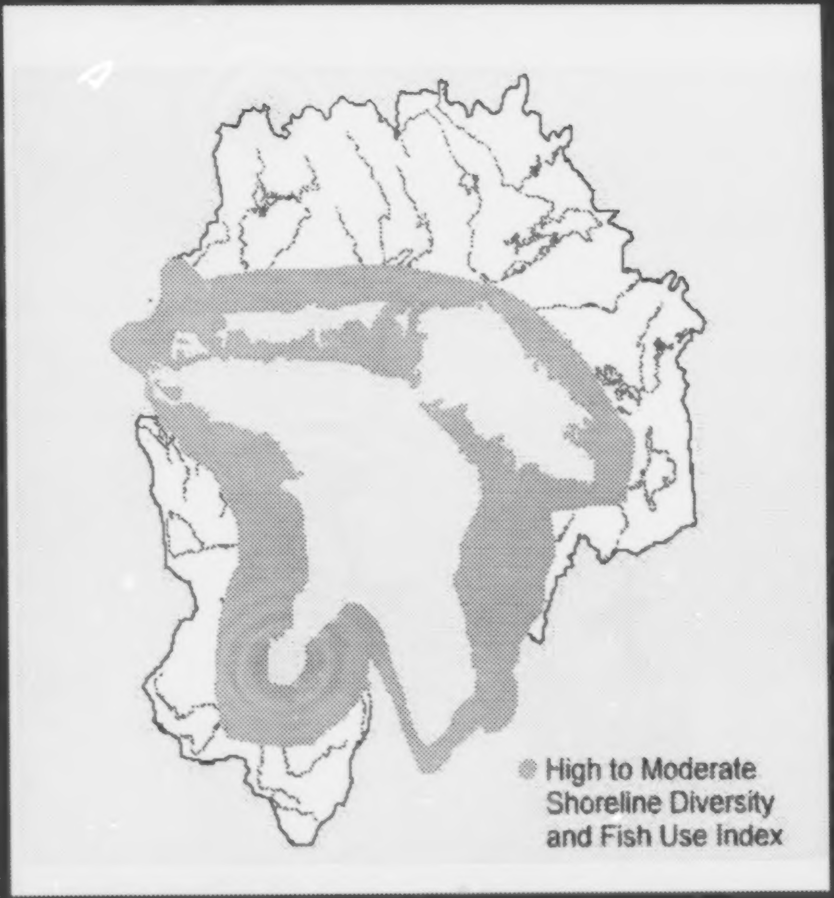
Courtesy of Ducks Unlimited

Habitat

- Saginaw Bay continues to provide essential fish and wildlife habitat
- Continued loss of wetlands is a serious threat to habitat

Biodiversity Investment Areas

- Many sections of Lake Huron have high ecological values which warrant exceptional attention.


● High to Moderate Shoreline Diversity and Fish Use Index

Critical Stresses

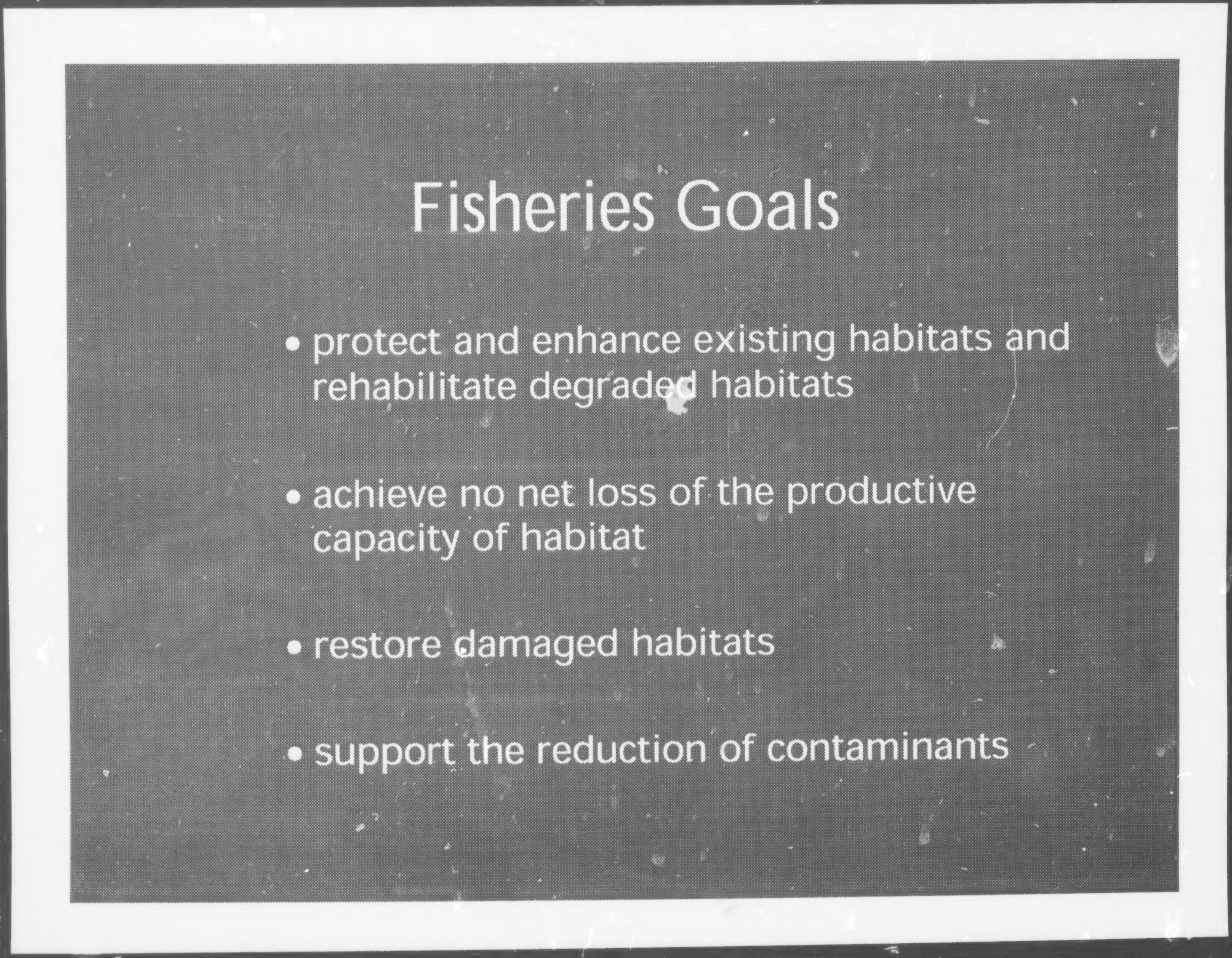
- Degradation and loss of historical habitat in tributaries
- Degradation and loss of near shore habitat
- Non-native species, over-fishing, and reproduction failure

Fishery Concerns

- Open water habitat remains steady
- Lake trout reproduction occurring but rate is not sufficient
- Fisheries dependent on hatchery production and non-native species

MICHIGAN
DEPT. NATURAL RESOURCES
FISH PLANTING UNIT

Courtesy of Michigan Department of Natural Resources

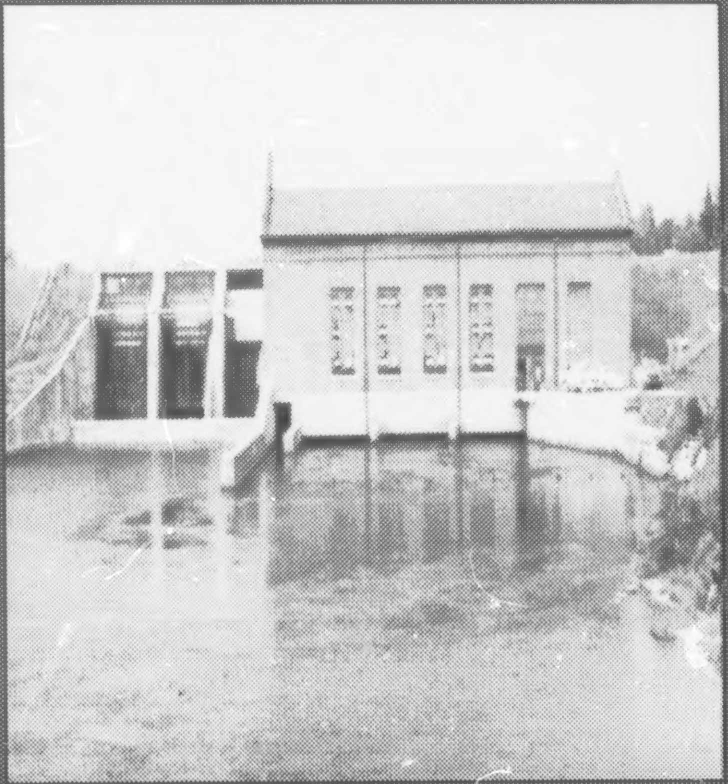


Fisheries Goals

- protect and enhance existing habitats and rehabilitate degraded habitats
- achieve no net loss of the productive capacity of habitat
- restore damaged habitats
- support the reduction of contaminants

Fishery Concerns

- Historically, tributaries were important sources of cool, high quality water serving as spawning and nursery habitat
- Fish have been excluded from many tributaries through construction of dams



Courtesy of Michigan Department of Natural Resources

Fishery Concerns

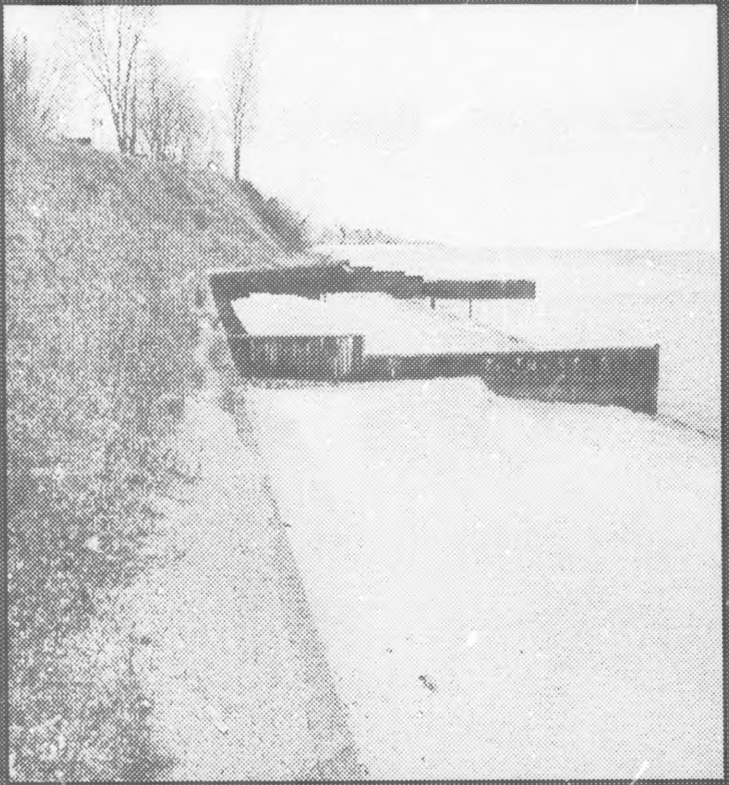
- A deterrent to achieving balanced fish communities is inadequate habitat for all life cycle stages

- Dams now fragment many streams where historical spawning occurred

Courtesy of Michigan Department of Environmental Quality

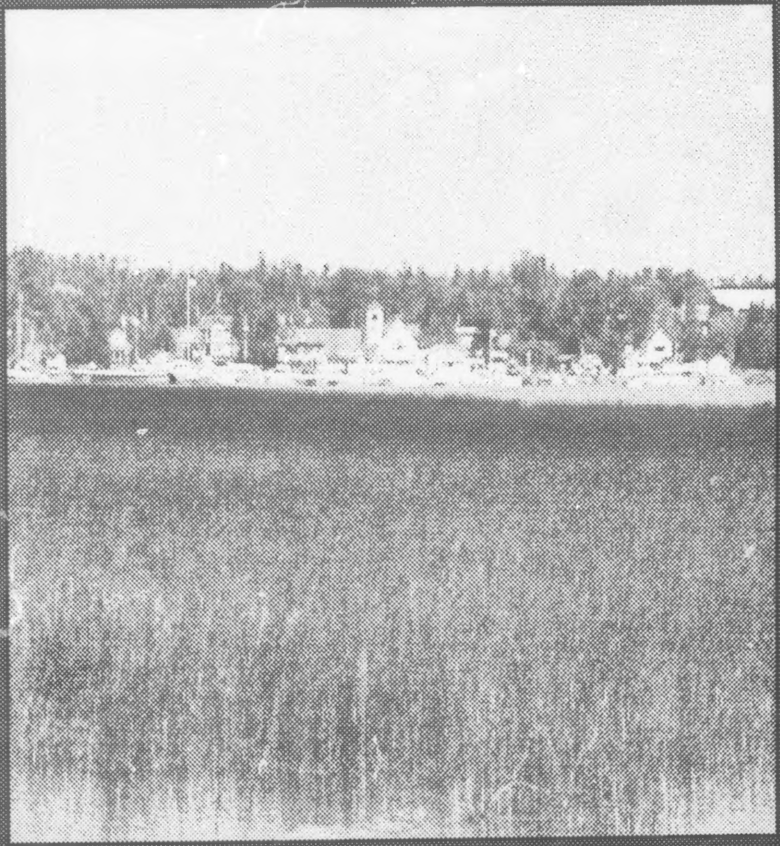
Nearshore Areas

- Many areas have been altered for shoreline protection structures
- In many cases, the band of transitional vegetation is now gone
- The cumulative impacts of these structures is significant and increasing



Coastal Wetlands

- Most losses have been around small urban centers on the lakeshore
- Losses has been due to agriculture, cottage development, road construction, dredging and channelization



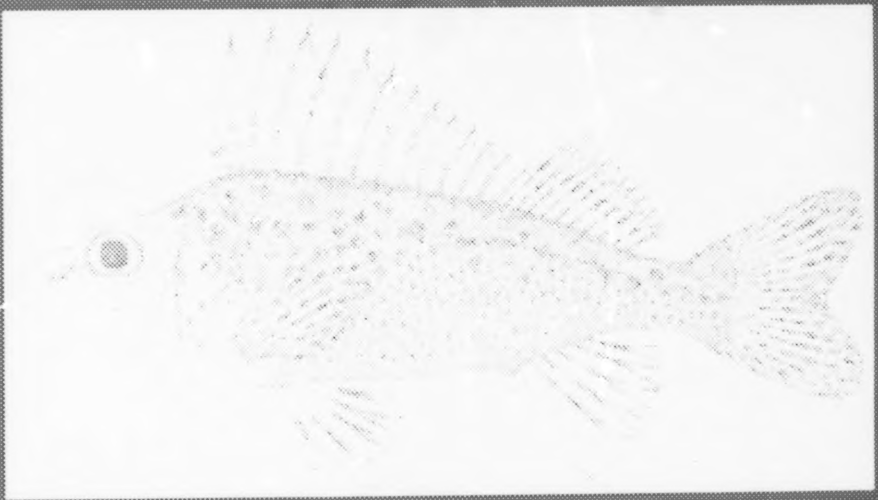
Coastal Wetlands

Current stresses on coastal wetlands include alteration of:

- habitat
- hydrology
- physical processes
- biological structure
- chemical regime

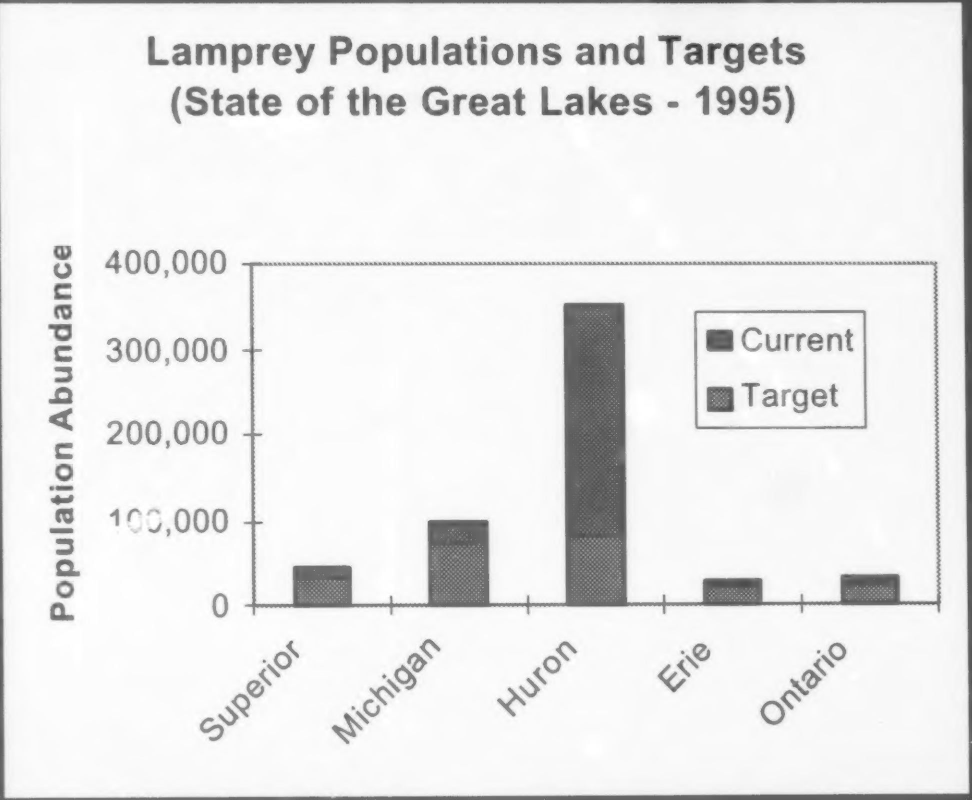
Non-native Species

- Non-native species causing significant stress include the sea lamprey, zebra mussel, ruffe, round goby, and purple loosestrife



Sea Lamprey

- The lamprey problem, associated with production from the St. Marys River, is the most severe impediment to a healthy fish community



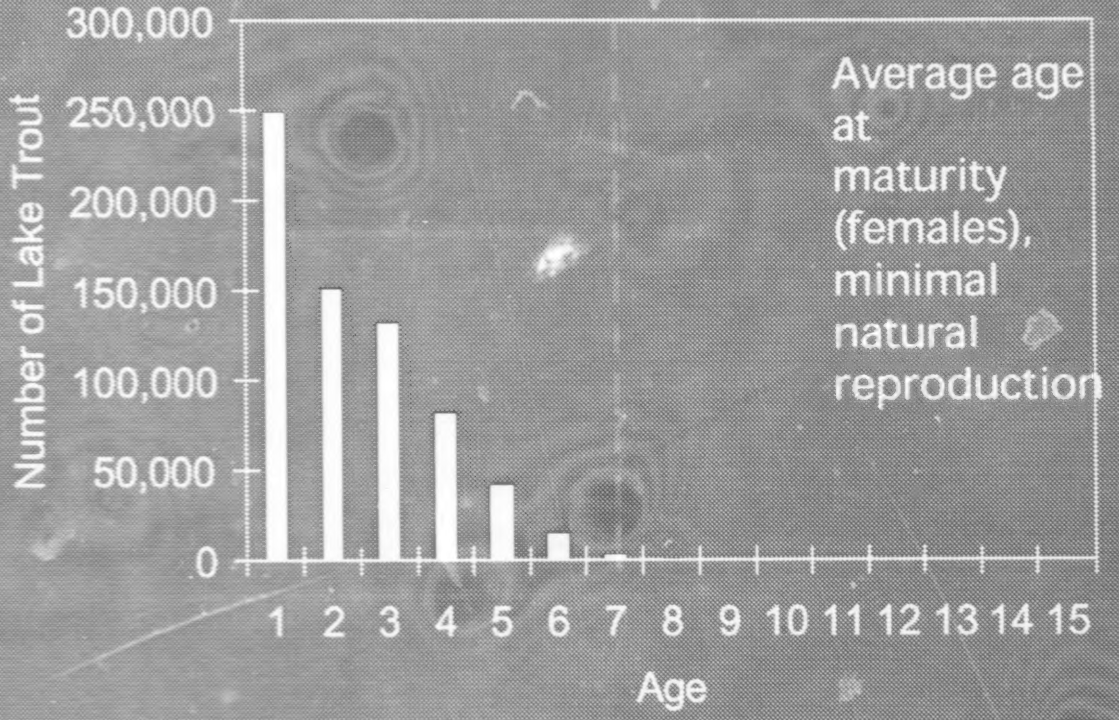
Lamprey Populations and Targets (State of the Great Lakes - 1995)

Sea Lamprey Control

- Cost-effective sea lamprey control on the St. Marys River may now be within reach
- The lamprey population is expected to be reduced by 85% by 2010

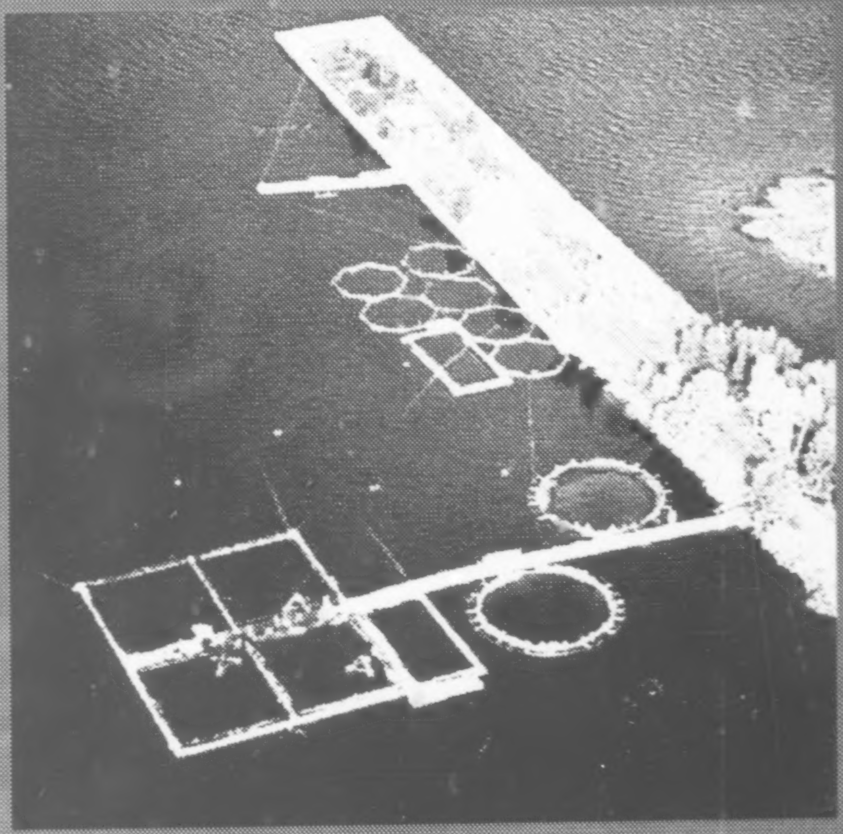
Courtesy of Great Lakes Fishery Commission

1983 TREATY NEGOTIATIONS: ENHANCED LAMPREY CONTROL LEVERAGES BETTER CONTROLS OF FISHING MORTALITY



Fish Farming - Aquaculture

- Concern from a fisheries and environmental perspective
- Now accounts for over 60 percent of rainbow trout production in Ontario waters



Courtesy of Ontario Ministry of Natural Resources

Lake Huron Initiative Action Plan

March 2000

Sudbury
Georgian Bay
Lake Huron
Goderich
Grand Bend
Saginaw
Flint
Sarnia

Prepared by:

Office of the Great Lakes
Michigan Department of
Environmental Quality

Key Actions Now Underway

- Michigan and Ontario are developing a bi-national GIS system
- Dredging the Pine and Saginaw Rivers
- Protecting habitat in the Saginaw Bay watershed
- Implementing the Conservation Reserve Enhancement Program in the Saginaw Bay watershed
- Securing funding to maintain a full lamprey control program

Actions Needed

- Controlling atmospheric inputs
- Aquatic nuisance species control program
- Restoring lost habitat
- Continuing progress in Areas of Concern
- Implementing watershed management plans
- Full funding for lamprey control program
- Local protection/restoration efforts
- Lower trophic level research
- Source control for pathogens (Saginaw Bay and Southeast Lake Huron

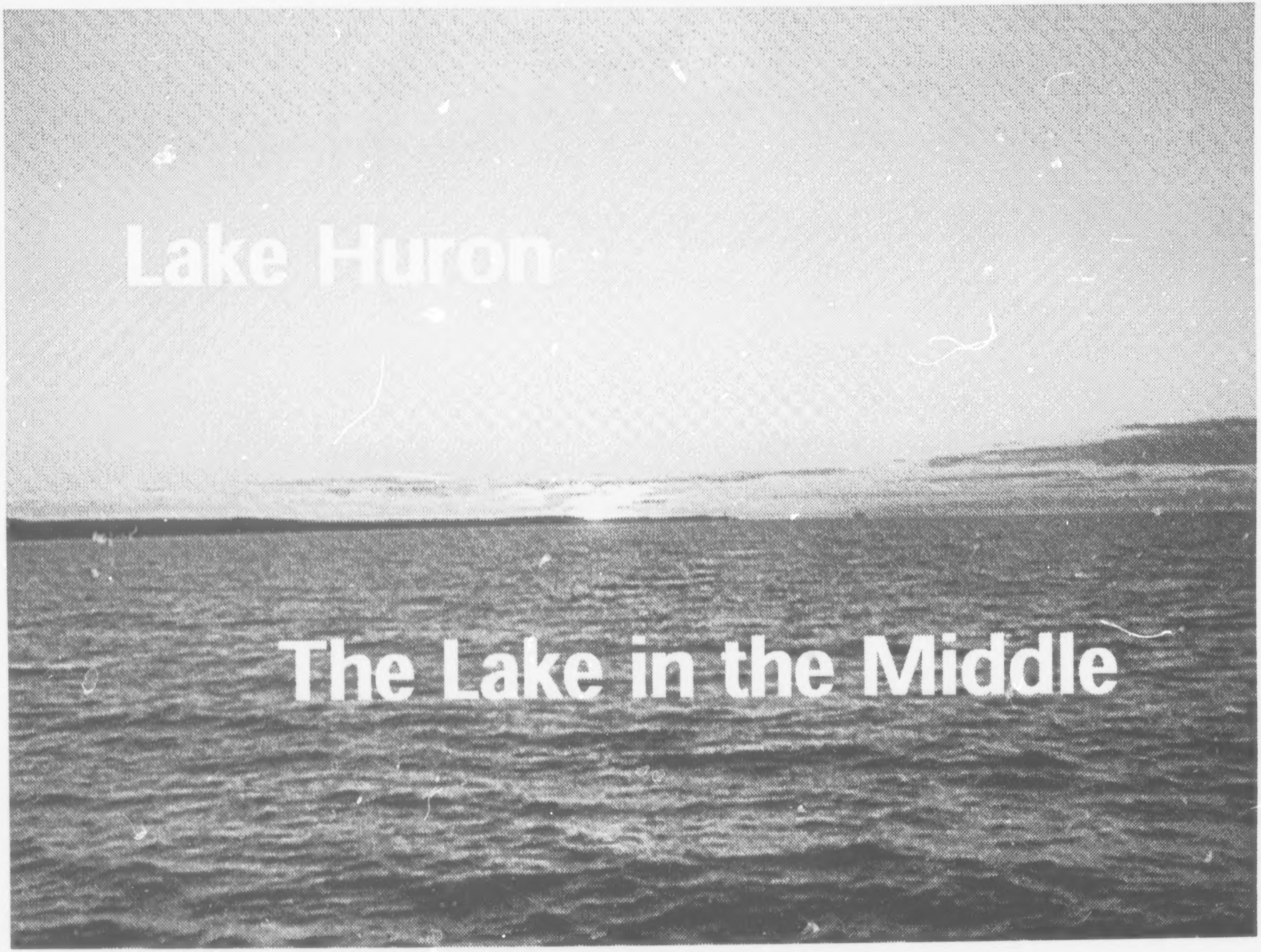
Conclusions

Point Source Controls	Good
Nonpoint Source Controls	Mixed
Atmospheric Deposition Controls	Poor
Nearshore Area Protection	Mixed
Hardened Shorelines	Poor
Tributary Habitat Restoration	Mixed
Control of Non-native Species	Mixed
Progress in Areas of Concern	Good

Lake Huron Initiative

- For additional information regarding the Lake Huron Initiative go to:

http:www.deq.state.mi.us/ogl/huron



Lake Huron

The Lake in the Middle

Lake Michigan
Lakewide
Management
Plan

Lake Michigan: Lake USA

Judy Beck

United States Environmental
Protection Agency

Lake Michigan Science, Status, Vision

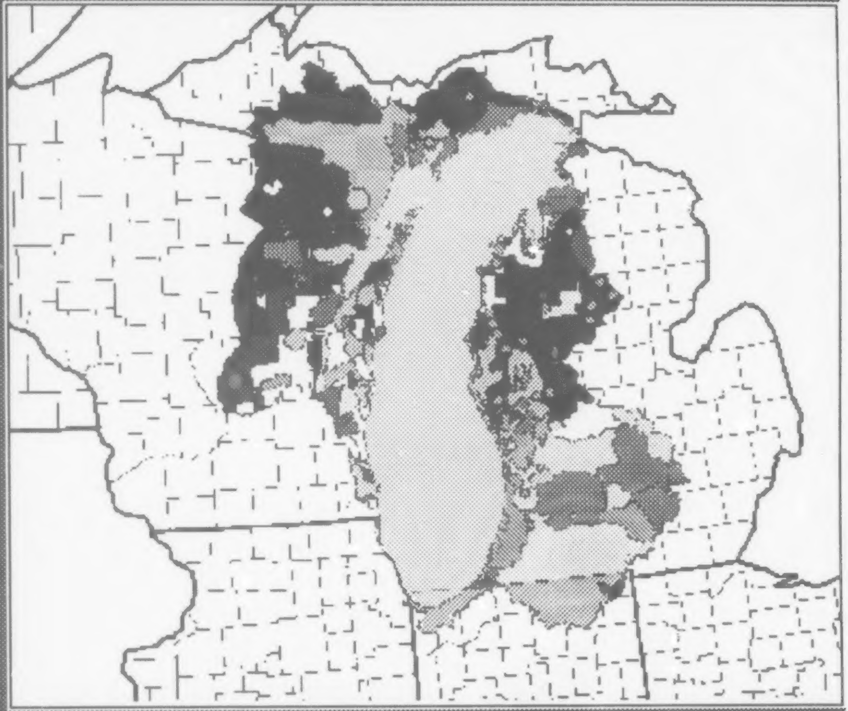
Developed by:

Lake Michigan Mass Balance Study
Great Lakes Fishery Commission

Lake Michigan
Lakewide
Management
Plan

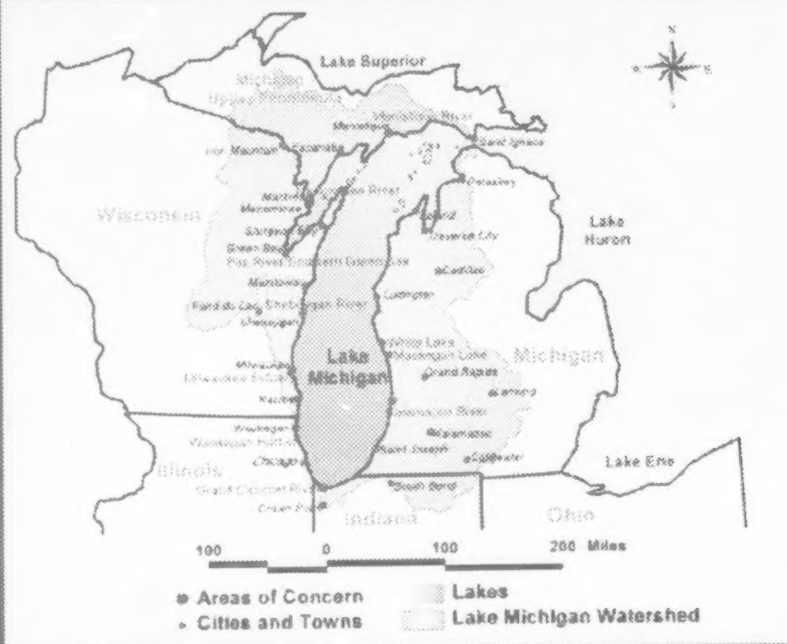
About Lake Michigan

- 2^{nd} largest by volume
- world's largest collection of fresh water dunes
- 40% of Coastal Wetlands, 26% of prime waterfowl (of the Great Lakes)
- 307 miles north to south leading to complex sub-ecosystem mixtures



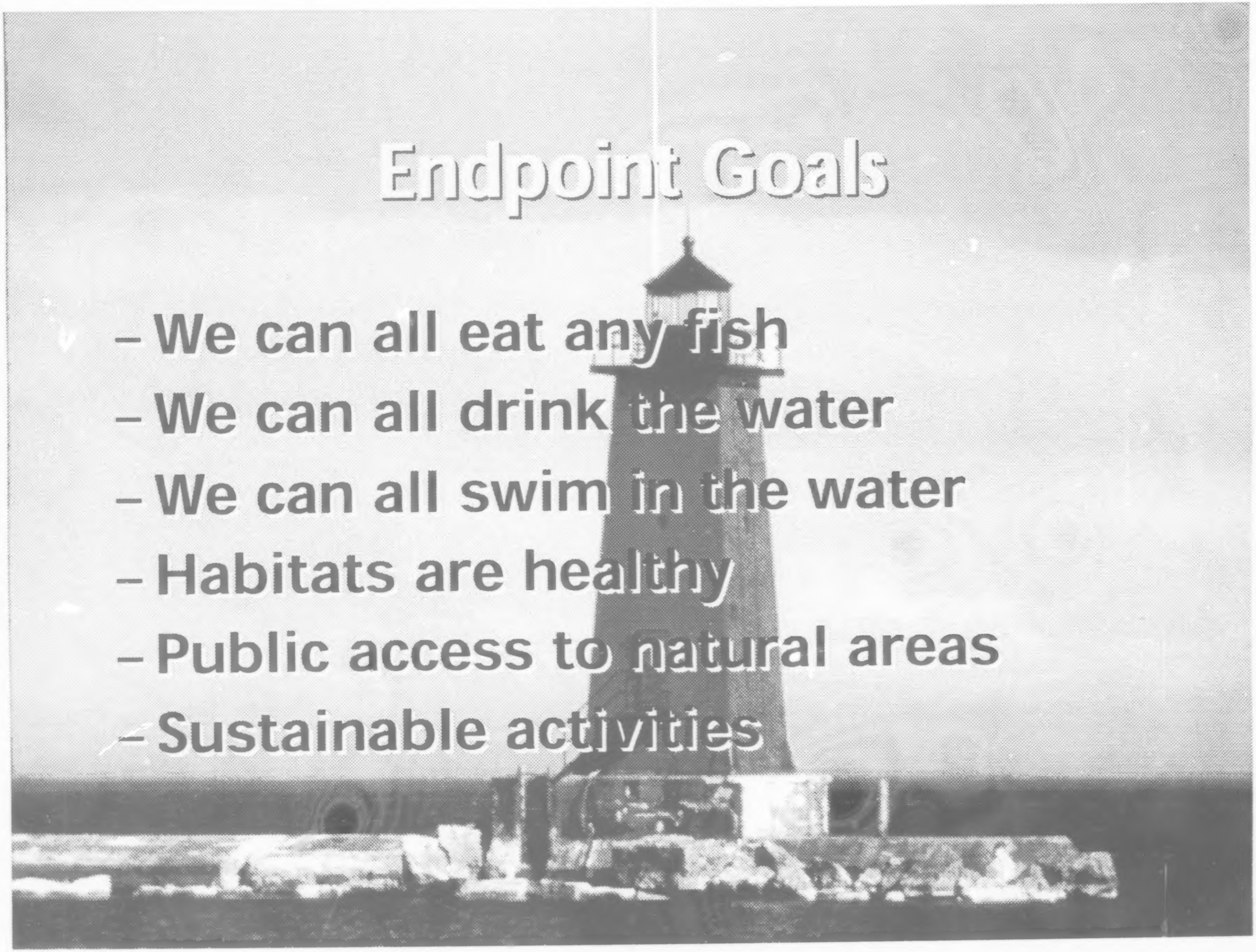
Lake Michigan Basin's 10 Areas of Concern

- Sediment cleanups at: Waukegan, Manistique, Menominee, Bryant Mill Pond
- Final plans: Indiana Harbor Ship Canal, Sheboygan, Kalamazoo
- Drawing board: Fox River Green Bay, Milwaukee Estuary, Muskegon and White Lakes


Lake Superior
N
Wisconsin
Michigan
Lake Huron
Lake Michigan
Illinois
Indiana
Ohio
Lake Erie
Grand Rapids
Chicago
100
0
100
200 Miles
● Areas of Concern
• Cities and Towns
Lakes
Lake Michigan Watershed

Lake Michigan:
Current Ecosystem Status

- Overview "an outstanding natural resource of global significance, under stress and in need of special attention"
- Beneficial use impairments presented spatially and temporally
- Cross-walk with LaMP goals



Endpoint Goals

- We can all eat any fish
- We can all drink the water
- We can all swim in the water
- Habitats are healthy
- Public access to natural areas
- Sustainable activities

We can all eat any fish
Ecosystem Status:

Impairment	Spatial	Temporal
Restrictions on fish and wildlife (F/W) consumption	Local	Ongoing
Tainting of F/W flavor	Local	Episodic

We can all drink the water Ecosystem Status:

Impairment	Spatial	Temporal
Restrictions on drinking water consumption or taste and odor problems	Local	Episodic

We can all swim in the water
Ecosystem Status:

Impairment	Spatial	Temporal
Beach closings	Local	Episodic

Habitats are healthy
Ecosystem Status:

Impairment	Spatial	Temporal
Degradation of F/W populations	Regional	Episodic
Fish Tumors or other deformities	Local	Episodic
Degradation of Benthos	Local	Ongoing
Eutrophication or undesirable algae	Local	Episodic

Habitats are healthy
Ecosystem Status:

Impairment	Spatial	Temporal
Degradation of phytoplankton and zooplankton	Lakewide	Ongoing
Loss of F/W habitat	Lakewide	Ongoing
Bird or animal deformities	Local	Episodic

Public access to natural areas
Ecosystem Status:

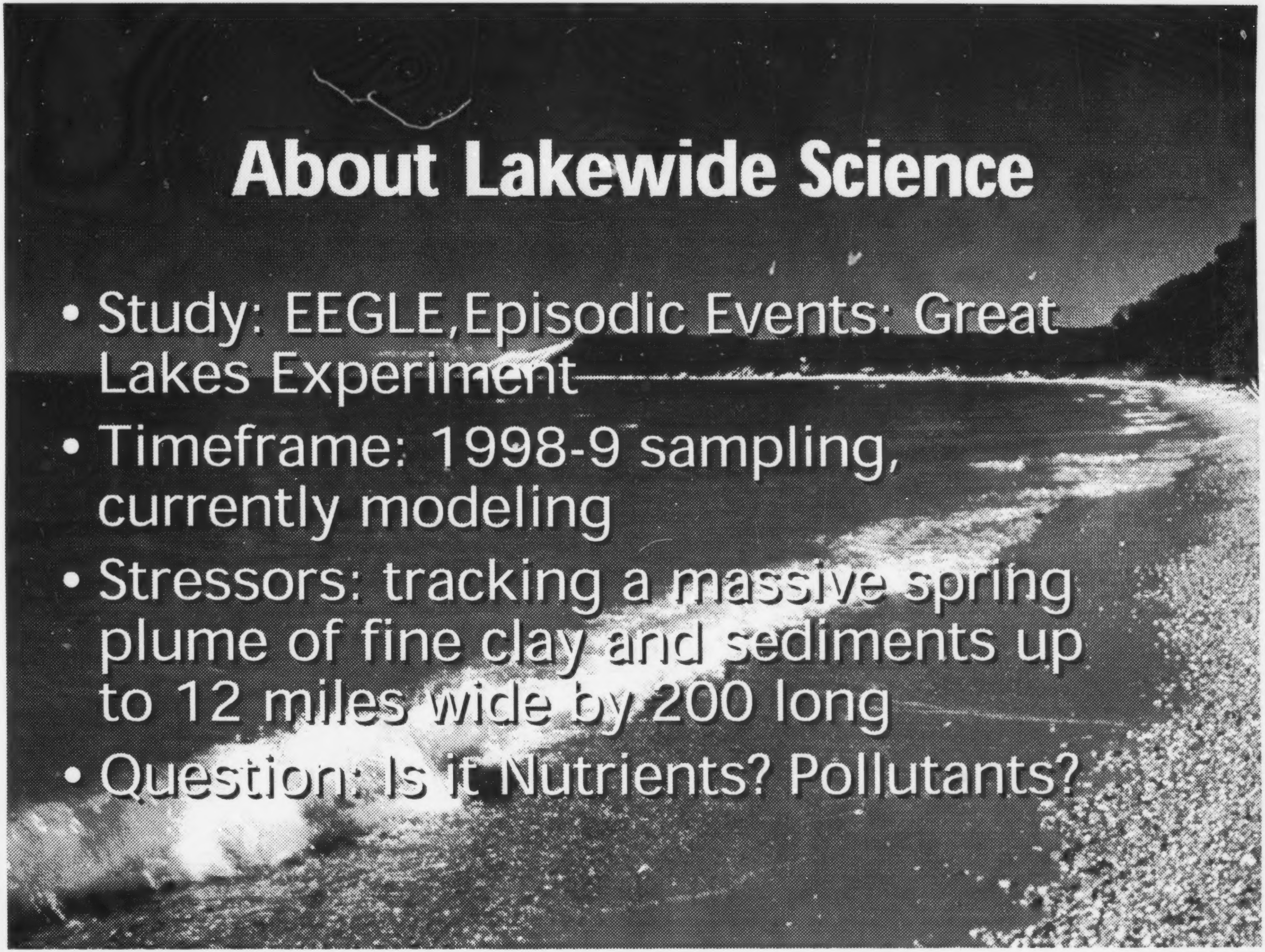
Impairment	Spatial	Temporal
Degradation of aesthetics	Local	Evolving

Sustainable activities Ecosystem Status:

Impairment	Spatial	Temporal
Restrictions on dredging	Local	Evolving
Added cost to agriculture or industry	Local	Evolving

Monitoring the Stressors

- Chemical:
  - PCBs/dioxins, Mercury, Pesticides, Nutrients
- Biological:
  - Aquatic Nuisance Species
  - Pathogens (local and exotic)
- Physical:
  - sediments, habitat destruction. Water flow change

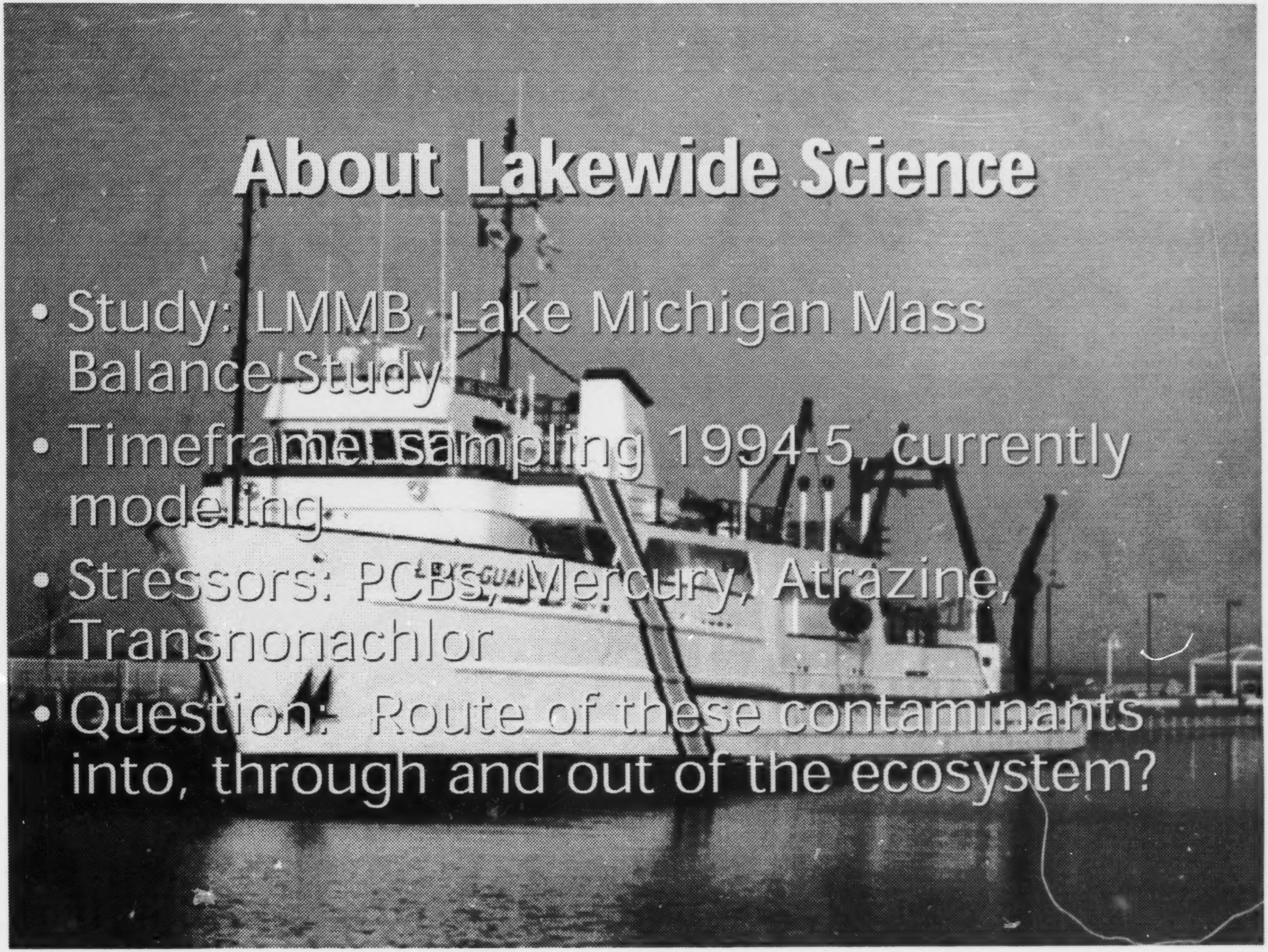


About Lakewide Science

- Study: EEGLE,Episodic Events: Great Lakes Experiment
- Timeframe: 1998-9 sampling, currently modeling
- Stressors: tracking a massive spring plume of fine clay and sediments up to 12 miles wide by 200 long
- Question: Is it Nutrients? Pollutants?

About Human Health Science

- Study:
  - ATSDR - Great Lakes Human Health Effects Research Program
  - States annual fish monitoring
- Stressors: persistent toxic chemicals
- Question: current data for fish advisories

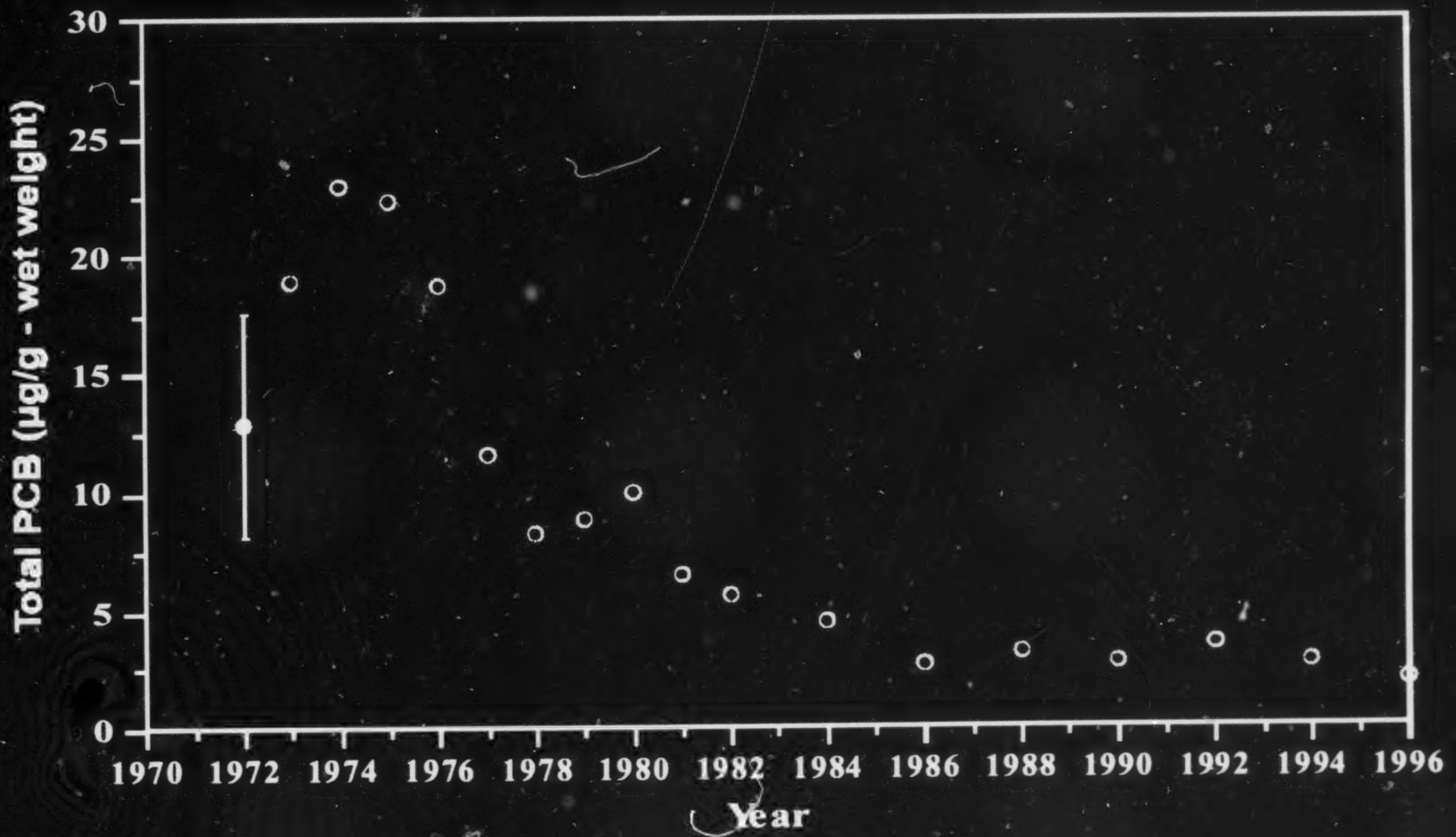


About Lakewide Science

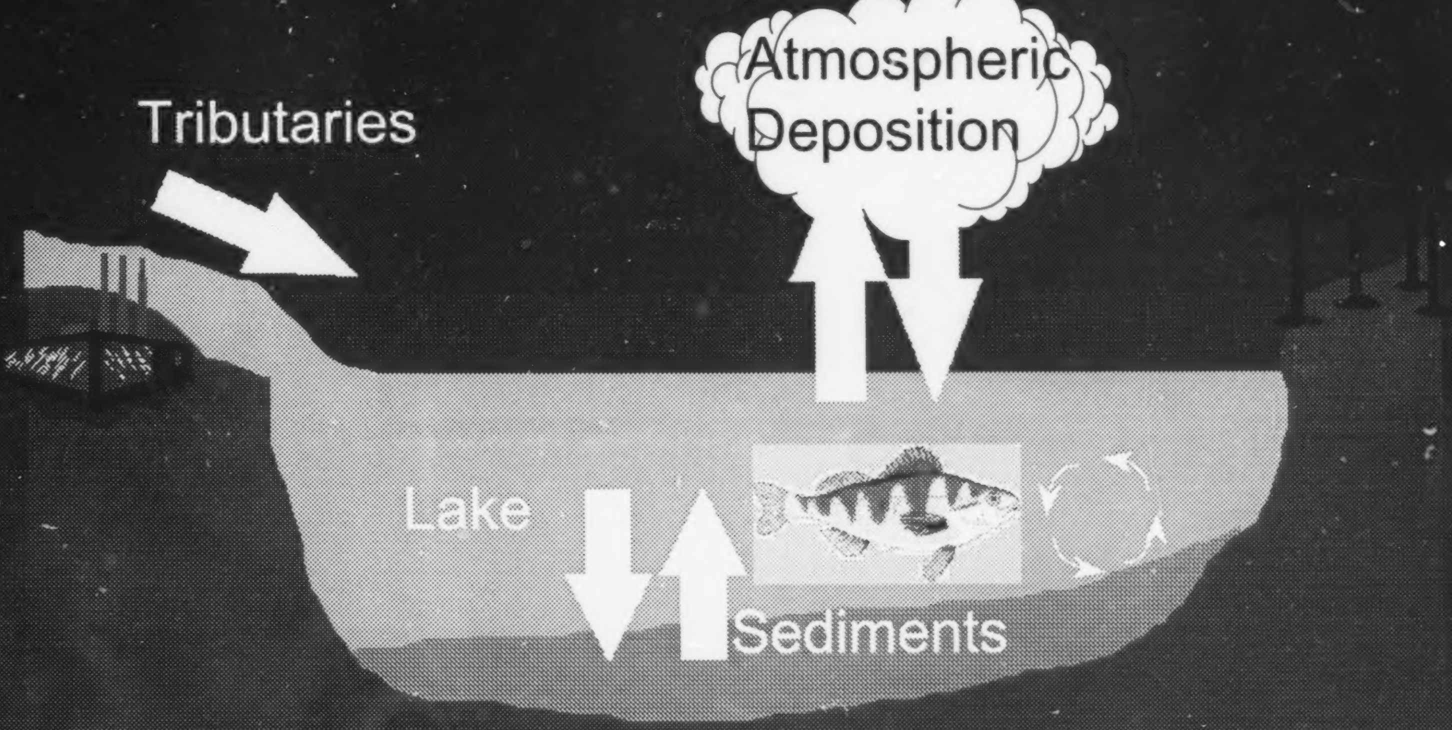
- Study: LMMB, Lake Michigan Mass Balance Study
- Timeframe: sampling 1994-5, currently modeling
- Stressors: PCBs, Mercury, Atrazine, Transnonachlor
- Question: Route of these contaminants into, through and out of the ecosystem?

Total PCB Concentrations in Lake Michigan Lake Trout

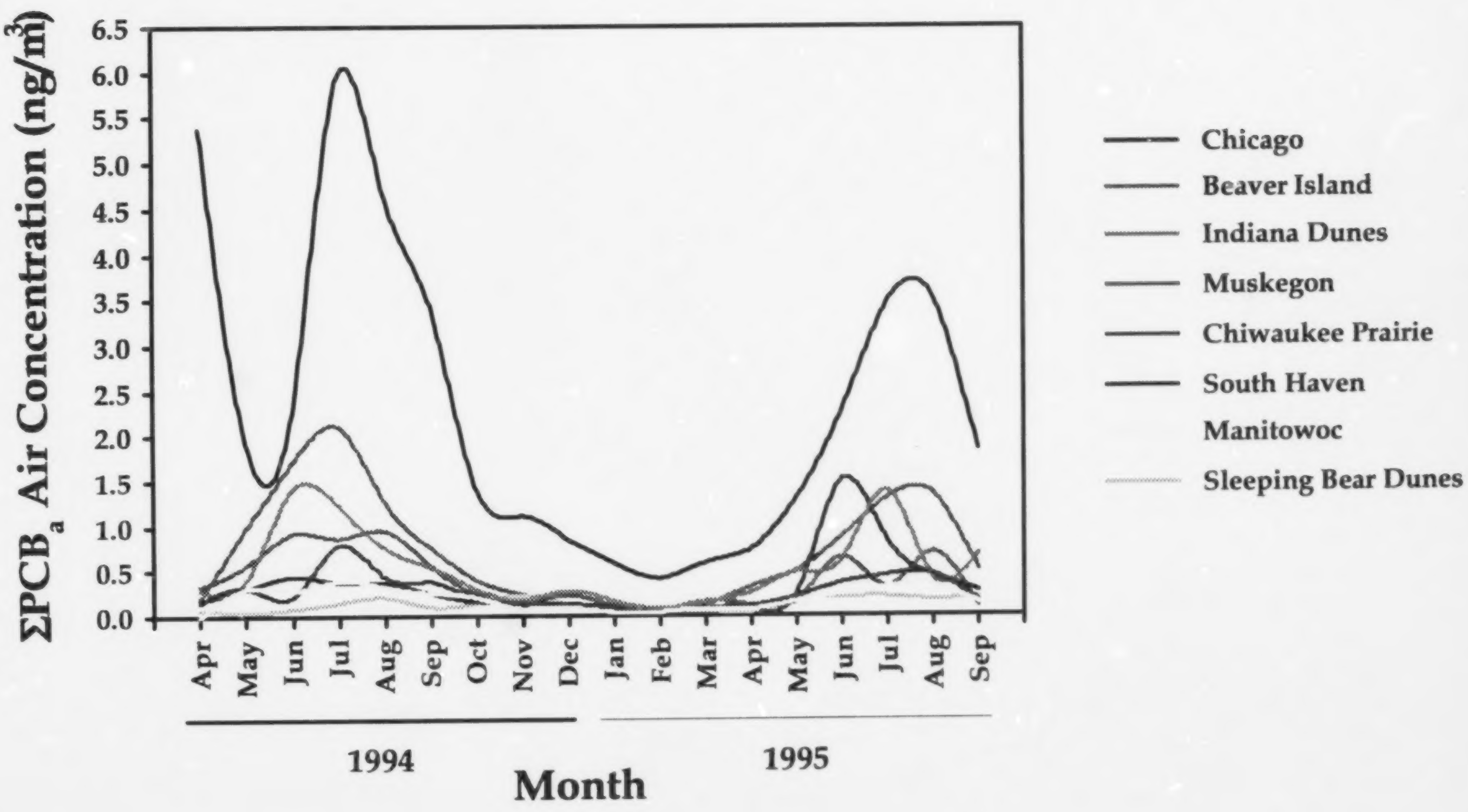
Error bars = 95% confidence limits



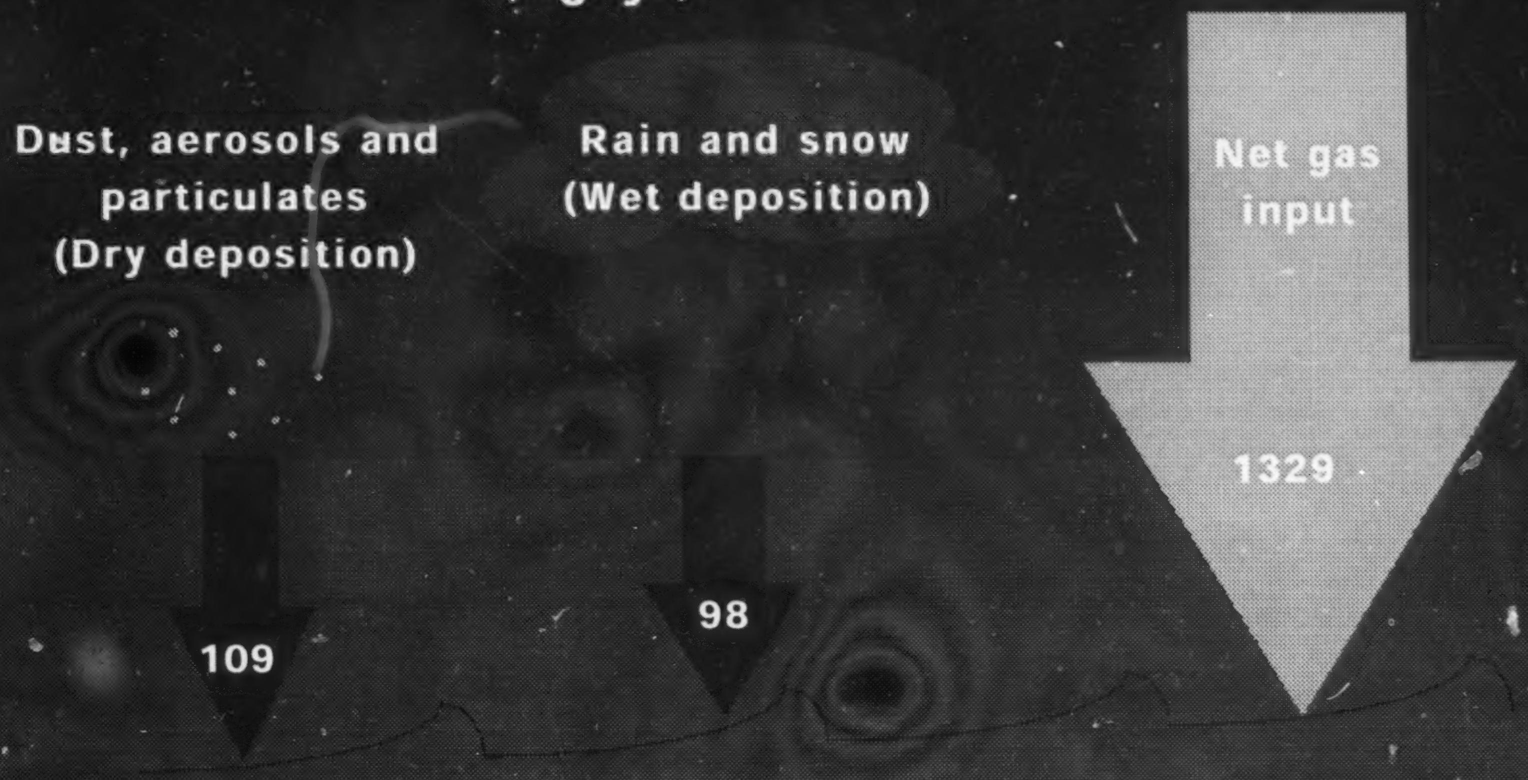
"Sources" of Toxics to Lake


Tributaries
Atmospheric Deposition
Lake
Sediments

Air Concentration Summary



PCB loadings for Lake Michigan
(kg/yr)



Dust, aerosols and particulates (Dry deposition)

109

Rain and snow (Wet deposition)

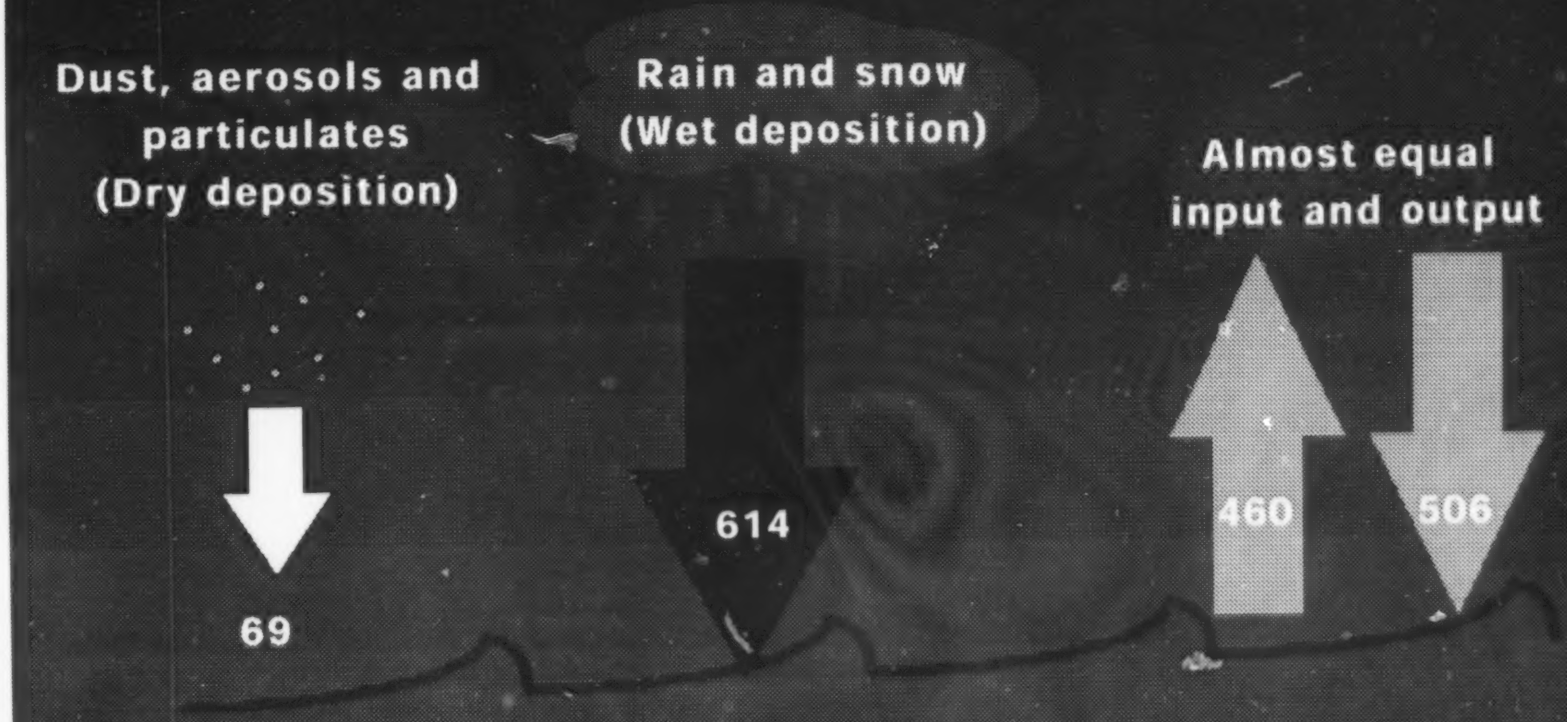
98

Net gas input

1329

Atmospheric Loading = 109 + 98 + 1329 - 0
= 1536 kilograms per year

Mercury Loadings for Lake Michigan (kg/yr)



Dust, aerosols and
particulates
(Dry deposition)

69

Rain and snow
(Wet deposition)

614

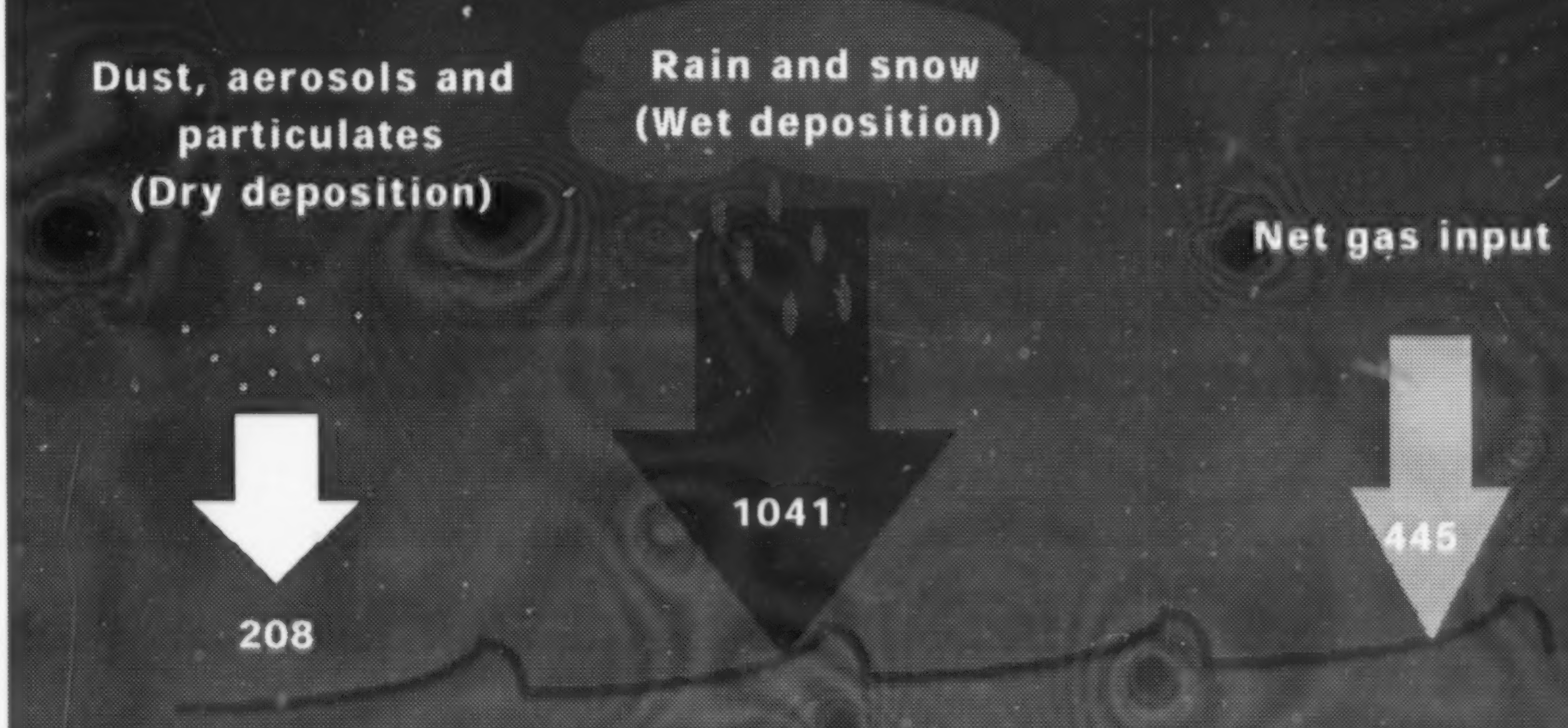
Almost equal
input and output

460

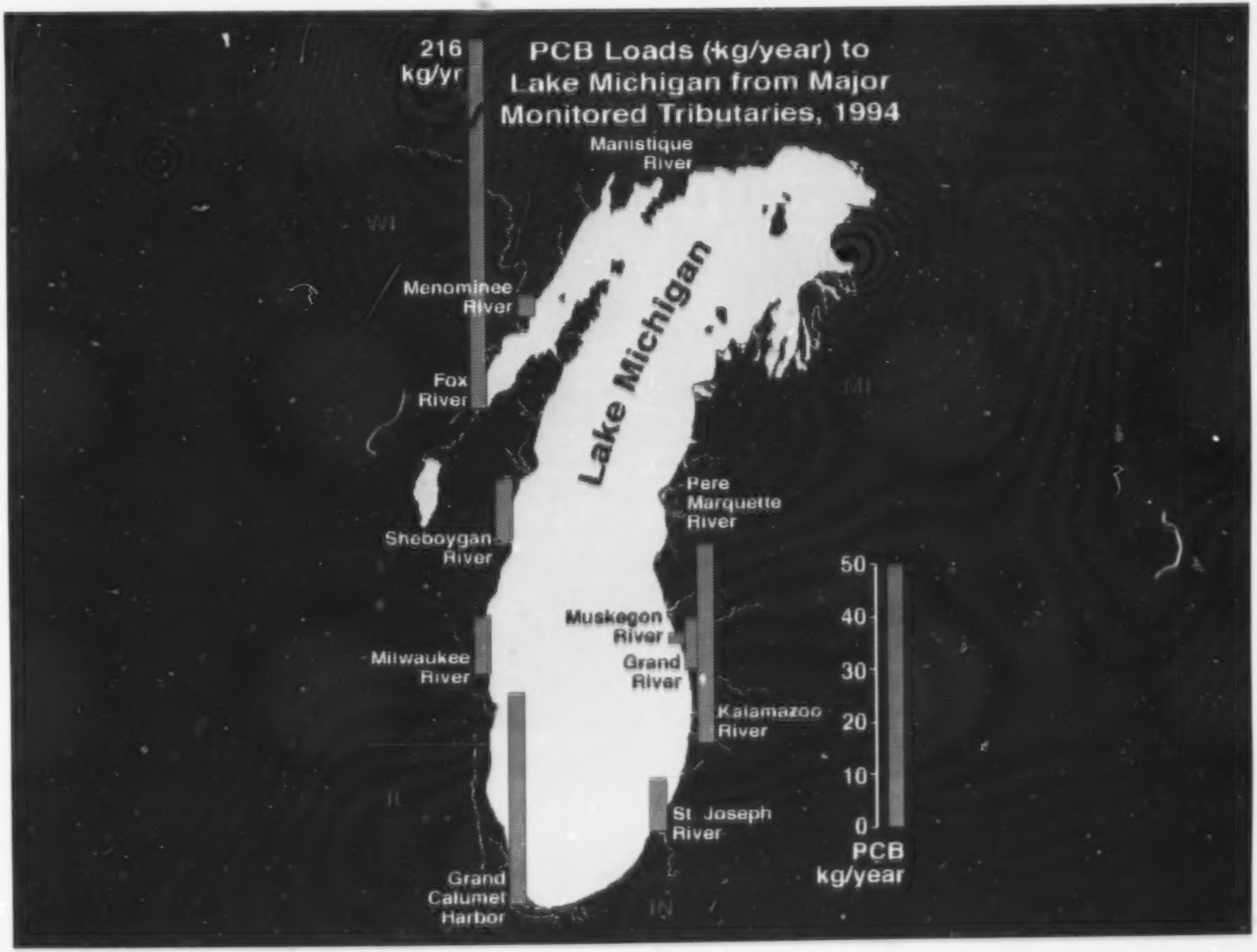
506

Atmospheric Loading = 69 + 614 + 506 - 460
= 729 kilograms per year

Atrazine loadings for Lake Michigan (kg/yr)

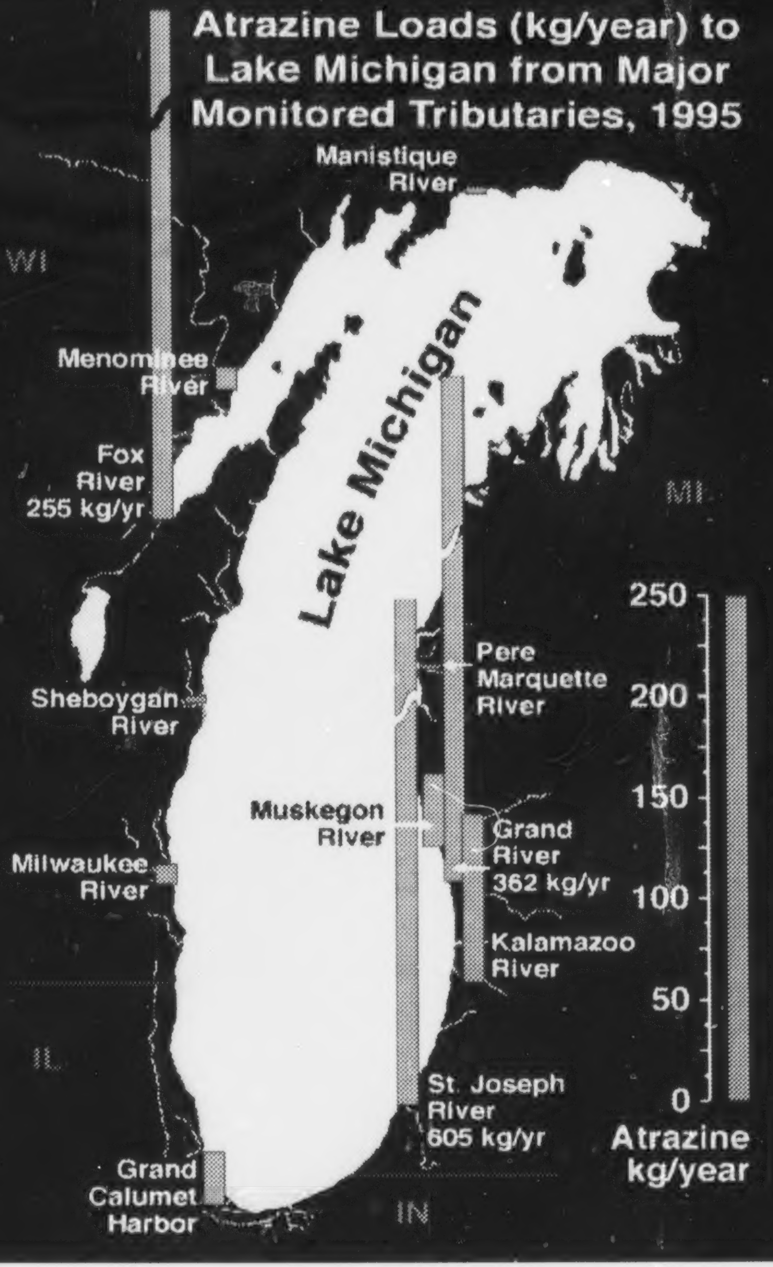

Dust, aerosols and particulates (Dry deposition)
Rain and snow (Wet deposition)
Net gas input
208
1041
445

Atmospheric Loading = 208 + 1041 + 445 - 0
= 1694 kilograms per year



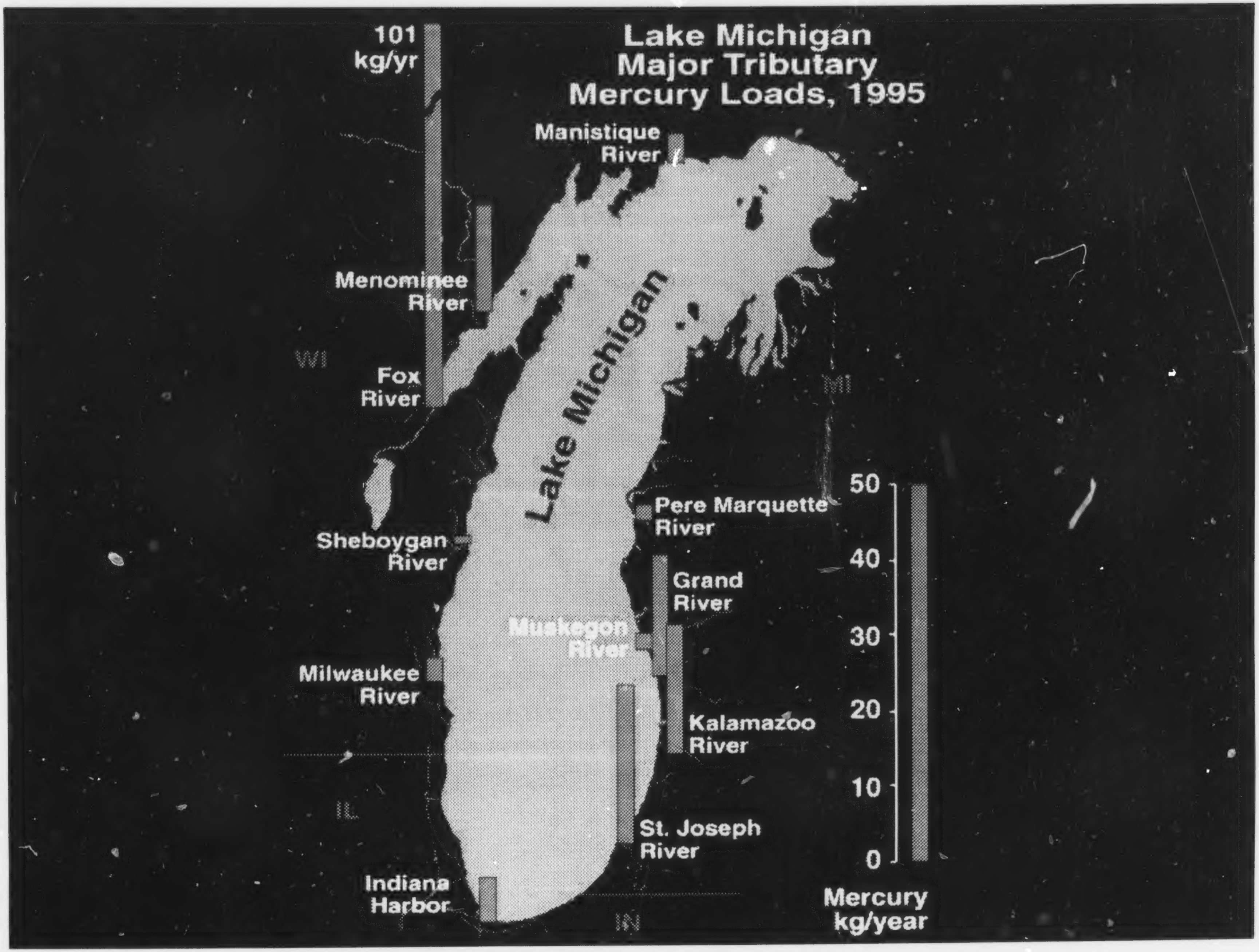
PCB Loads (kg/year) to Lake Michigan from Major Monitored Tributaries, 1994

216
kg/yr
Manistique River
Menominee River
Fox River
Sheboygan River
Milwaukee River
Grand Calumet Harbor
Lake Michigan
Pere Marquette River
Muskegon River
Grand River
Kalamazoo River
St. Joseph River
WI
MI
IL
IN
50
40
30
20
10
0
PCB
kg/year



Atrazine Loads (kg/year) to Lake Michigan from Major Monitored Tributaries, 1995

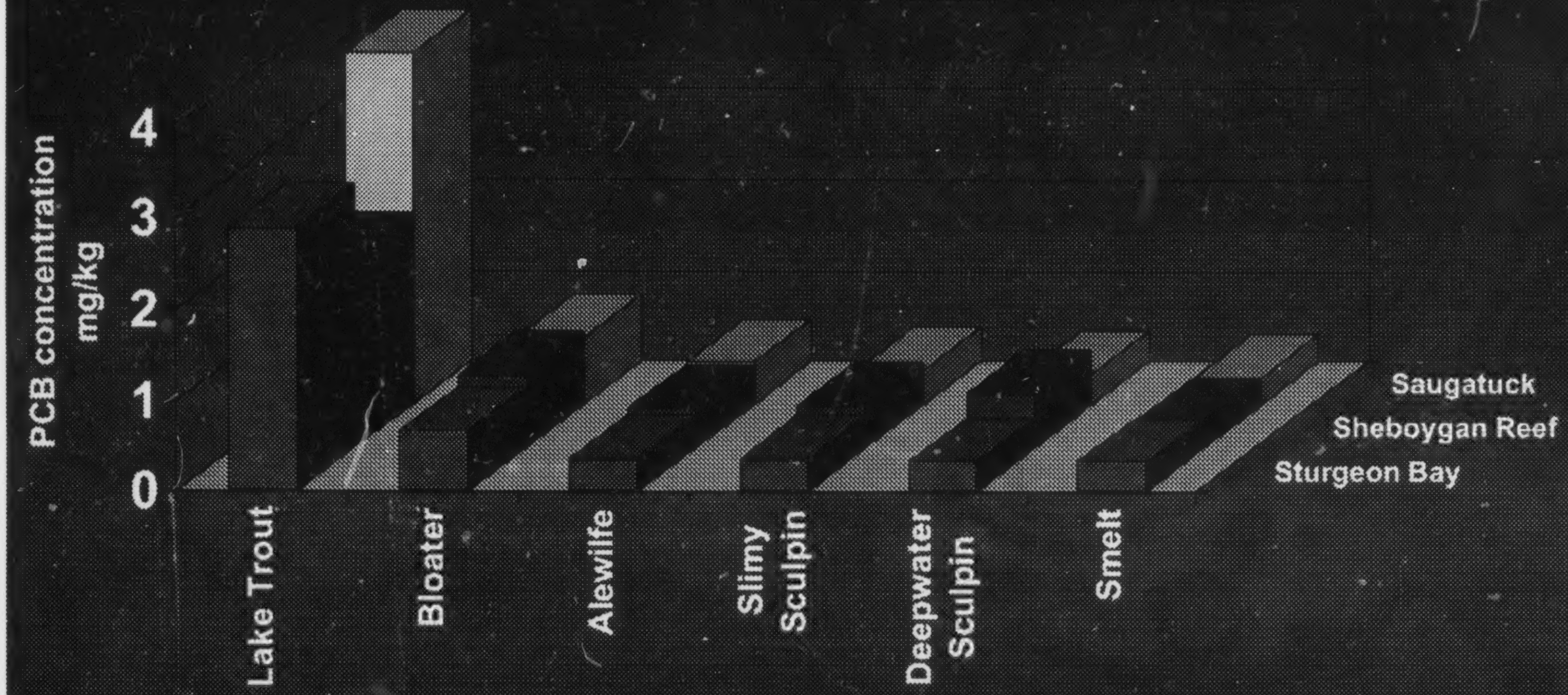
Manistique River
WI
MI
IL
IN
Lake Michigan
Menominee River
Fox River 255 kg/yr
Sheboygan River
Milwaukee River
Grand Calumet Harbor
Pere Marquette River
Muskegon River
Grand River 362 kg/yr
Kalamazoo River
St. Joseph River 605 kg/yr
250
200
150
100
50
0
Atrazine kg/year

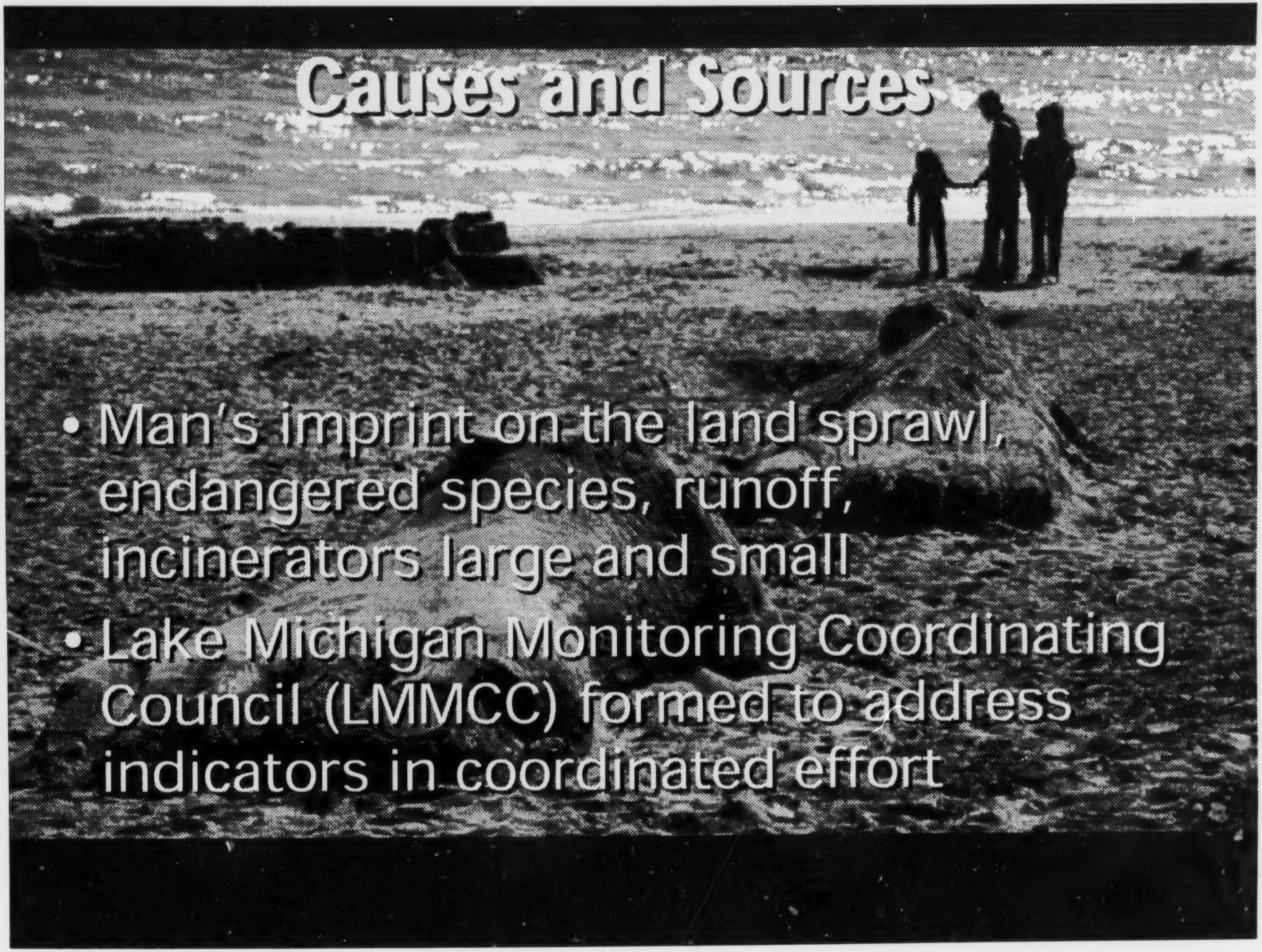


Lake Michigan Major Tributary Mercury Loads, 1995

101 kg/yr
Manistique River
Menominee River
Fox River
WI
Lake Michigan
MI
Sheboygan River
Pere Marquette River
Grand River
Muskegon River
Milwaukee River
Kalamazoo River
IL
St. Joseph River
Indiana Harbor
IN
50
40
30
20
10
0
Mercury kg/year

LMMB Biota: PCBs in Predator and Forage Fish





Causes and Sources

- Man's imprint on the land sprawl, endangered species, runoff, incinerators large and small
- Lake Michigan Monitoring Coordinating Council (LMMCC) formed to address indicators in coordinated effort

Goal and Vision

- *"To restore and protect the integrity of the Lake Michigan ecosystem through collaborative, place-based partnerships."*
- To create *"a sustainable Lake Michigan ecosystem that ensures environmental integrity and that supports and is supported by economically viable healthy human communities."*

Acknowledgements

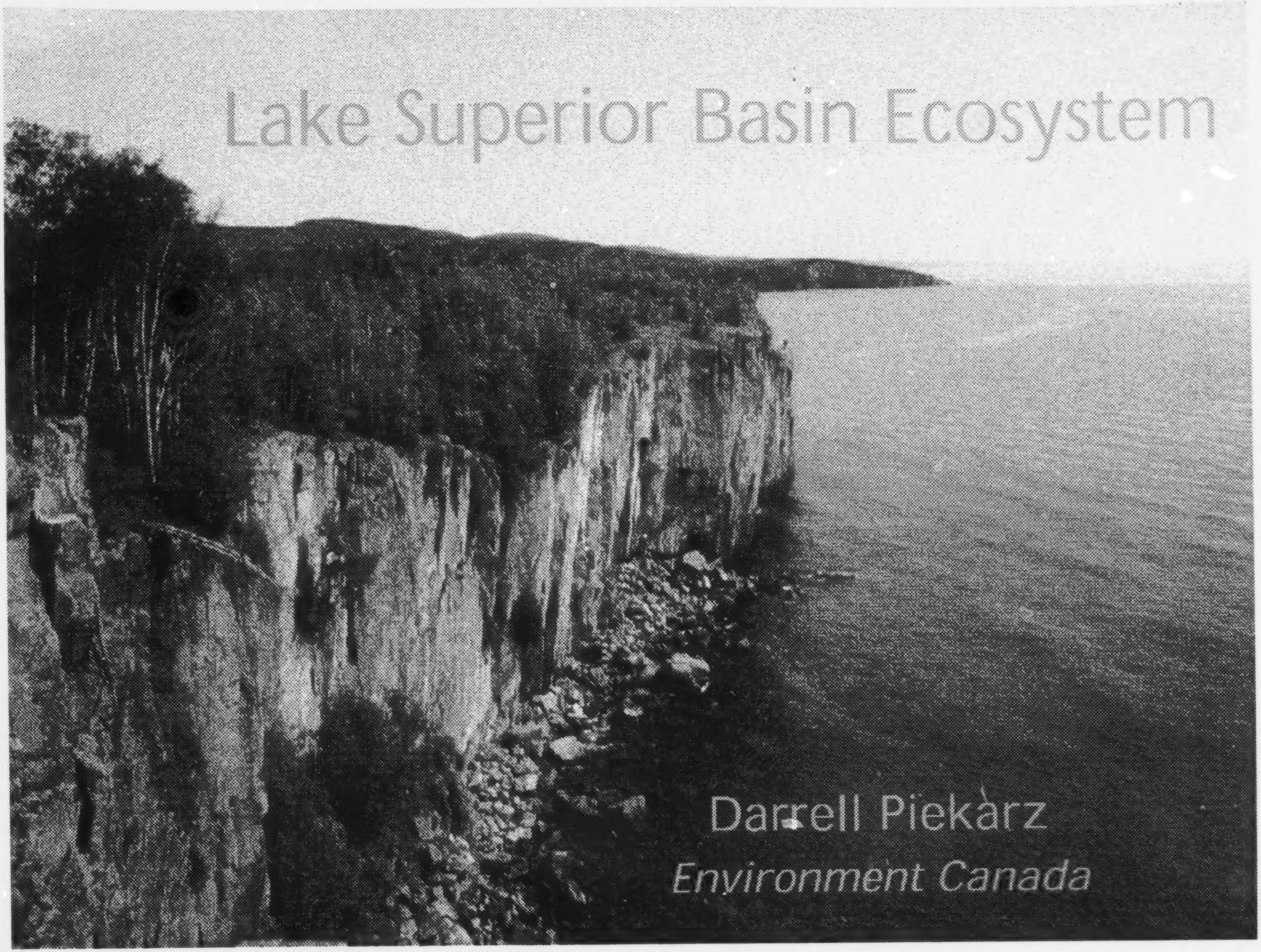
- Agency for Toxic Substances and Disease Registry
- Chippewa-Ottawa Treaty fishery Management Authority
- Grand Traverse Band of Ottawa and Chippewa Indians
- Great Lakes Fishery Commission
- Illinois Environmental Protection Agency

Acknowledgements

- Indiana Department of Environmental Management
- Michigan Department of Environmental Quality
- Oneida Tribe, Wisconsin
- US Army Corps of Engineers
- US Department of Agriculture, NRCS

Acknowledgements

- US Environmental Protection Agency
- US Fish and Wildlife Service
- US Geological Survey
- Wisconsin Department of Natural Resources

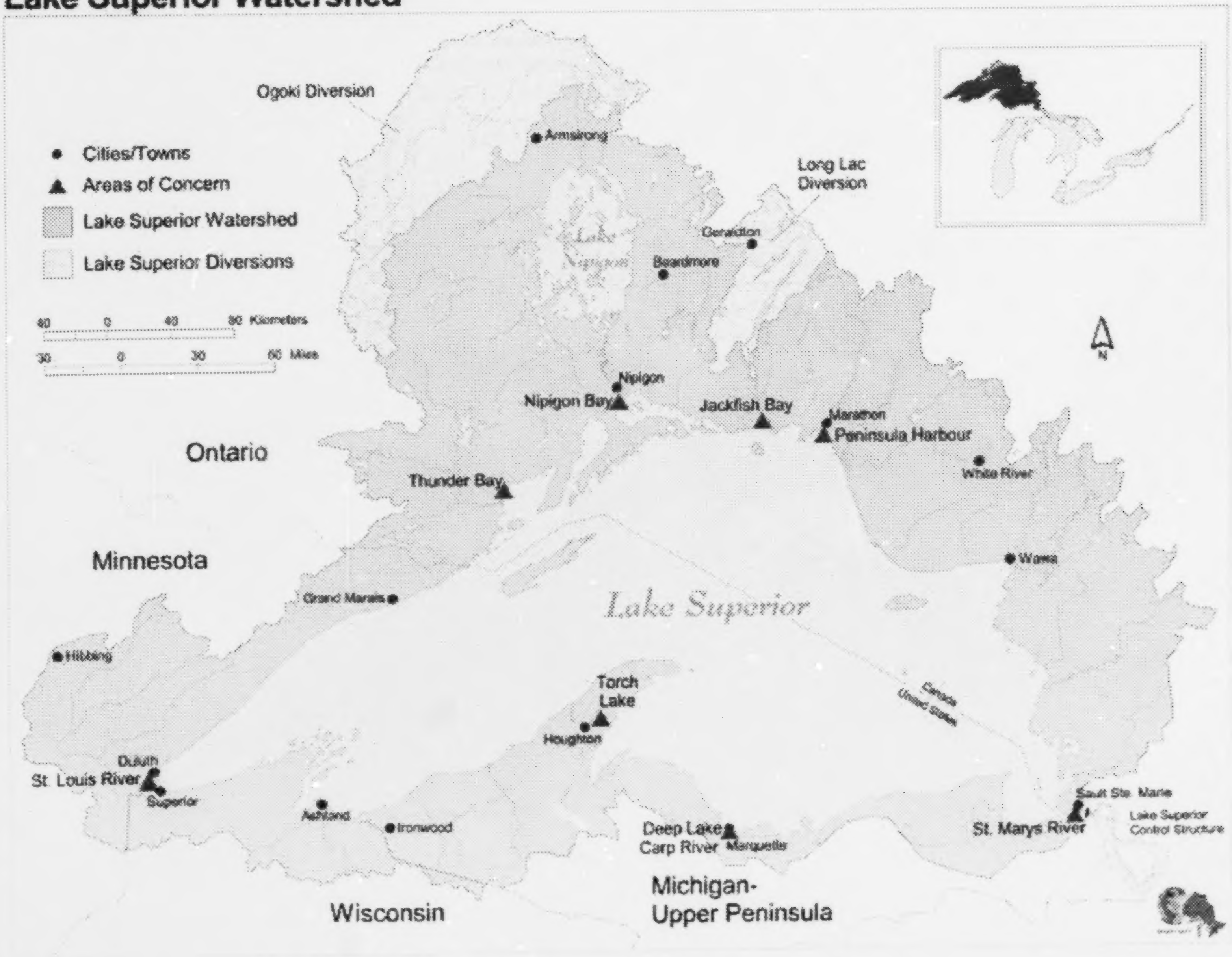


Lake Superior Basin Ecosystem

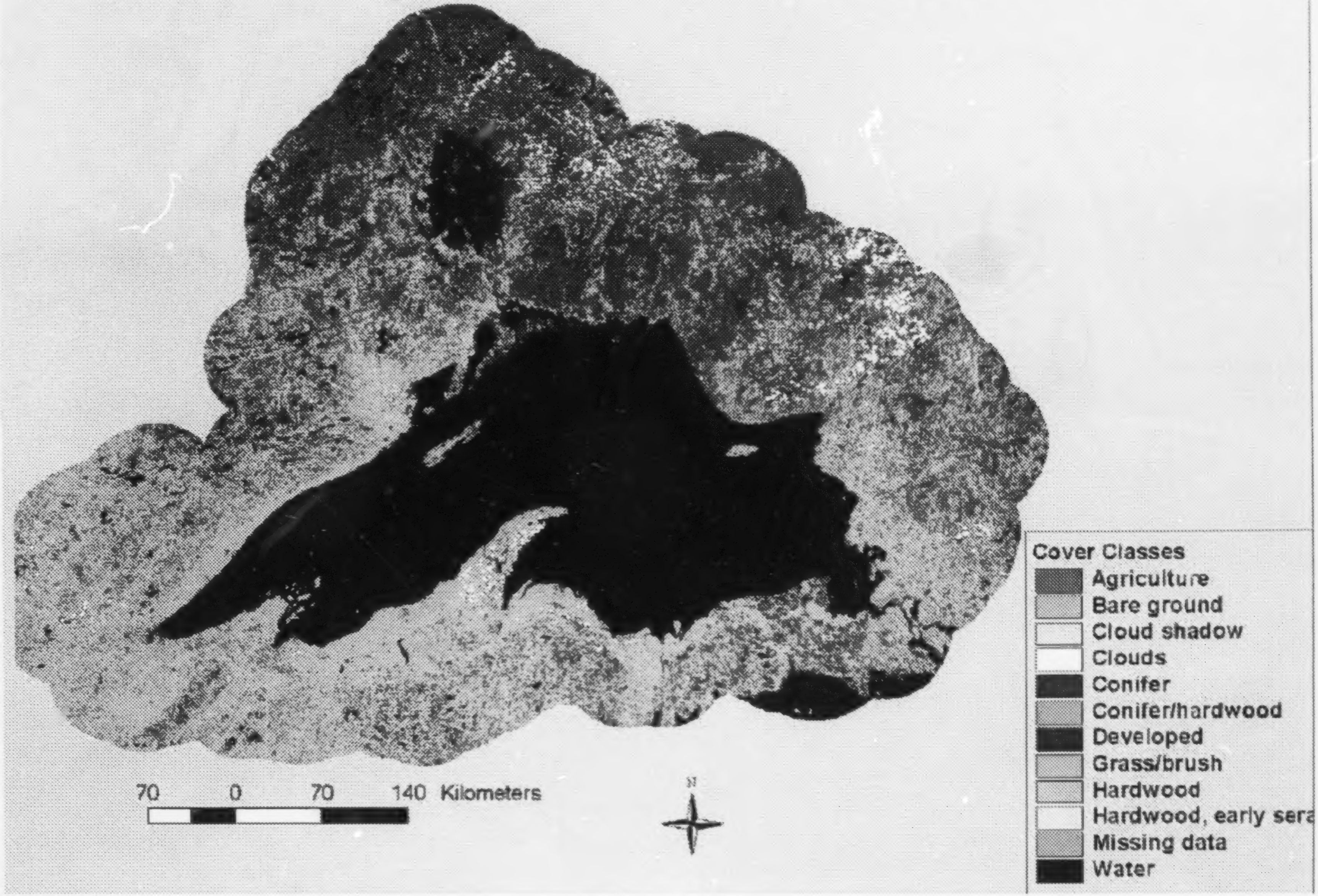
Darrell Piekarz

Environment Canada

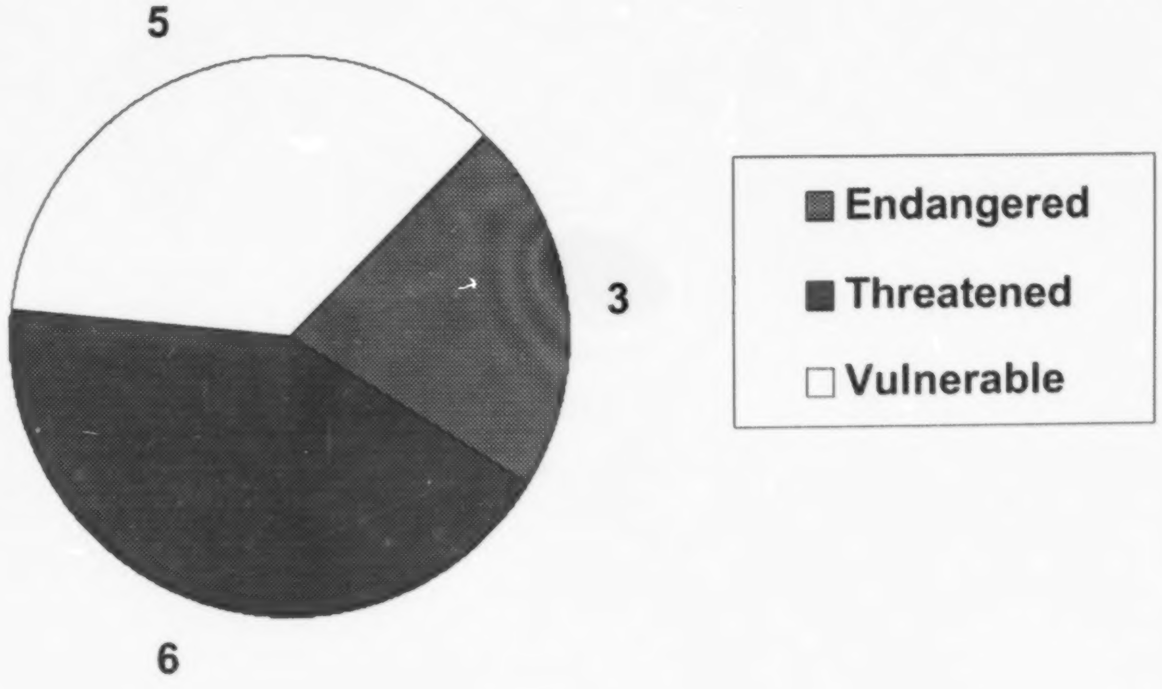
Lake Superior Watershed


Ogoki Diversion
Cities/Towns
Areas of Concern
Lake Superior Watershed
Lake Superior Diversions
40 0 40 80 Kilometers
30 0 30 60 Miles
Armstrong
Long Lac Diversion
Geraldton
Beardmore
Lake Nipigon
Nipigon
Nipigon Bay
Jackfish Bay
Marathon
Peninsula Harbour
White River
Ontario
Thunder Bay
Minnesota
Wawa
Grand Marais
Lake Superior
Hibbing
Torch Lake
Houghton
Canada
United States
Duluth
St. Louis River
Superior
Ashland
Ironwood
Deep Lake
Carp River
Marquette
Sault Ste. Marie
St. Marys River
Lake Superior Control Structure
Michigan-Upper Peninsula
Wisconsin
N

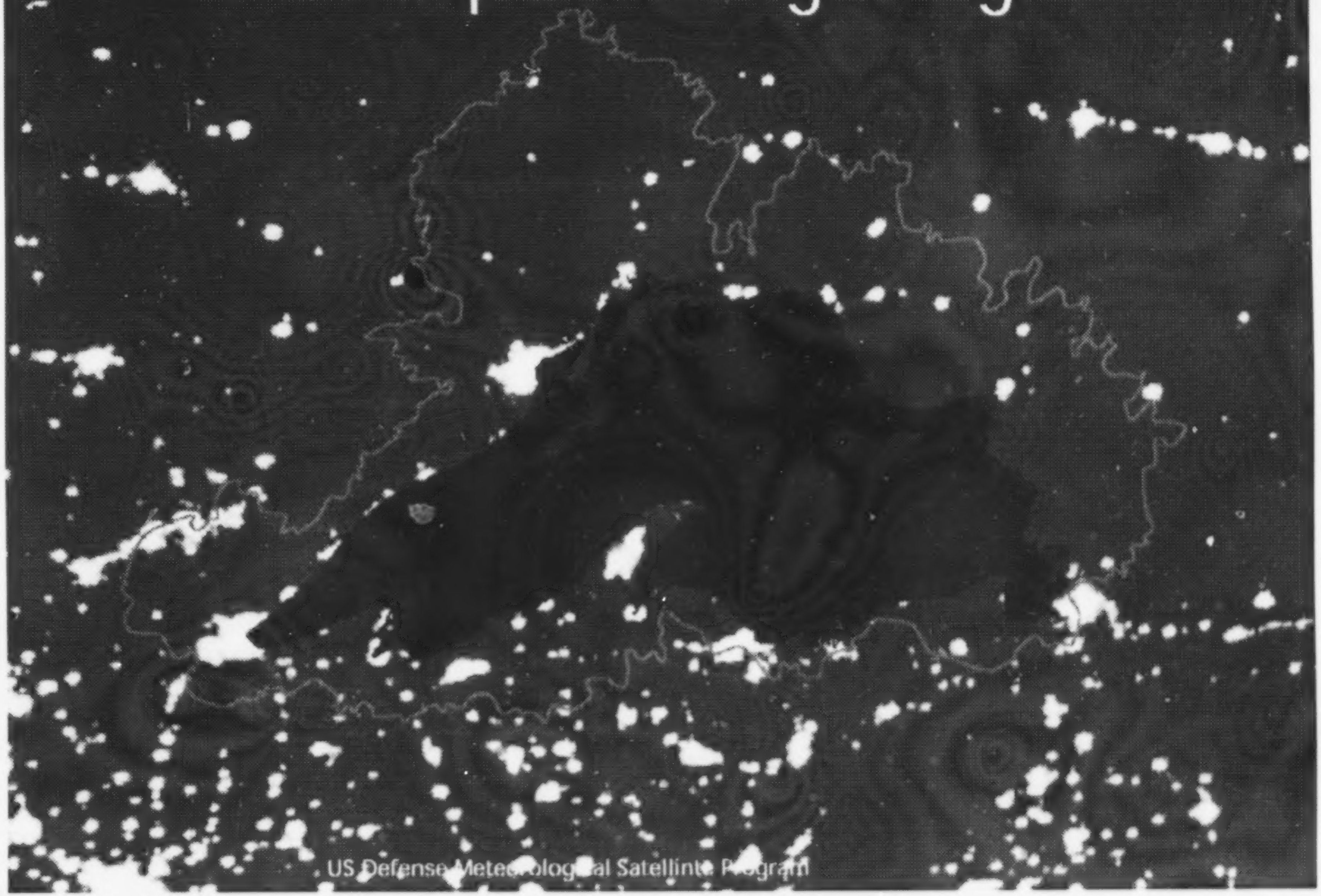
Lake Superior Basin Land Cover


Cover Classes
Agriculture
Bare ground
Cloud shadow
Clouds
Conifer
Conifer/hardwood
Developed
Grass/brush
Hardwood
Hardwood, early sera
Missing data
Water
70 0 70 140 Kilometers
N

Lake Superior Endangered Species



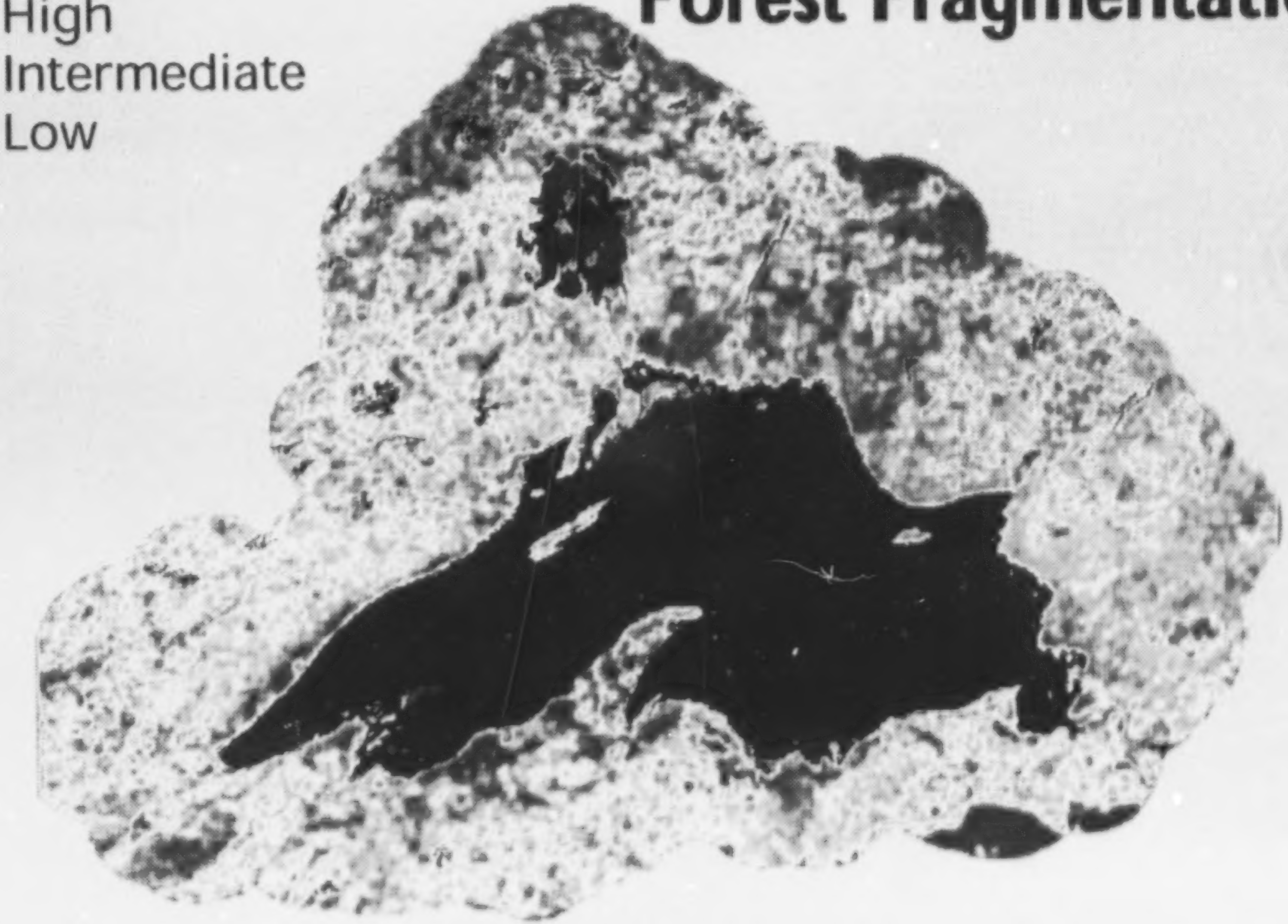
Lake Superior Night Lights



US Defense Meteorological Satellite Program

Forest Fragmentation

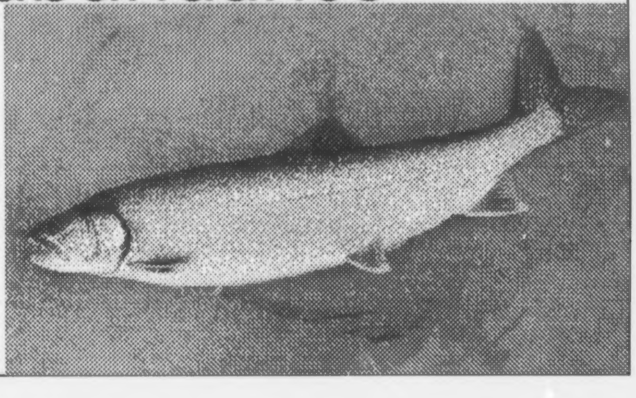
▨ High
☐ Intermediate
■ Low



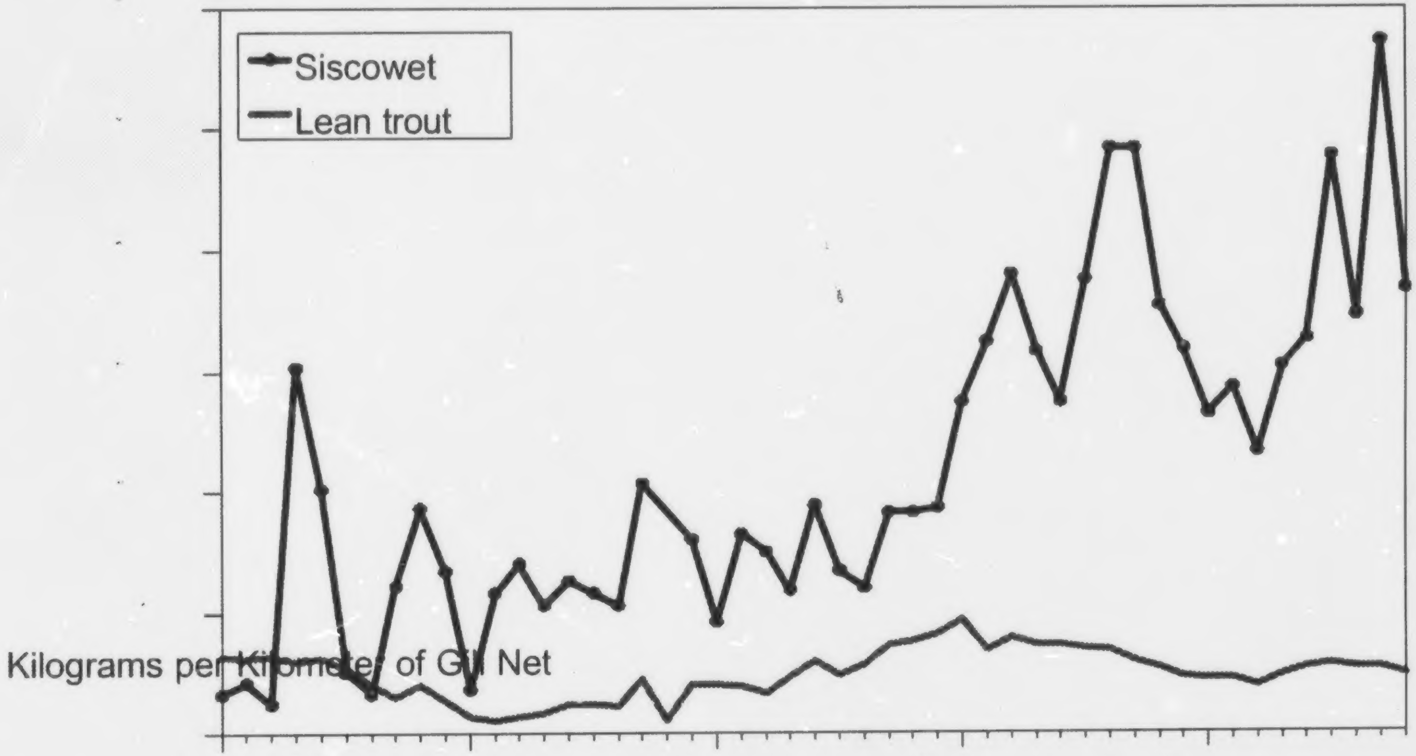
University of Minnesota

Aquatic Communities

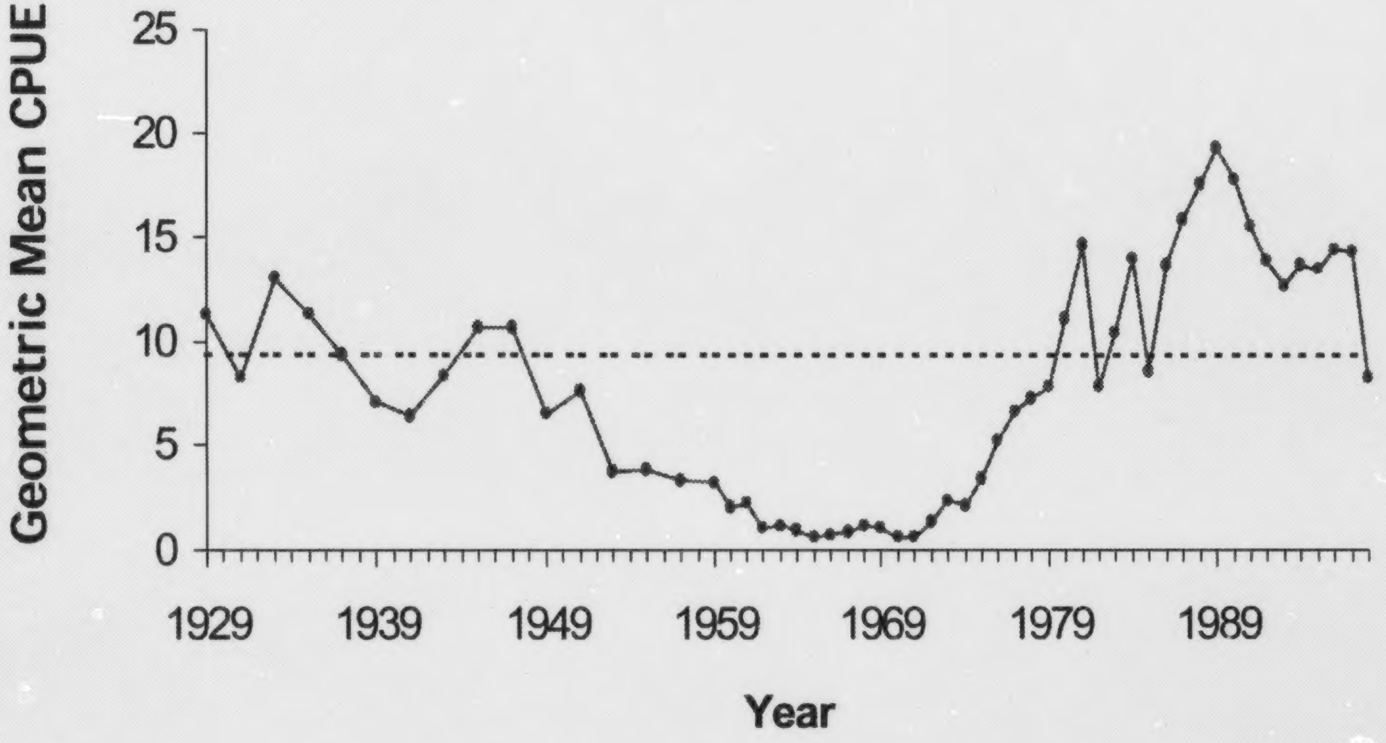
- Superior is the Great Lake closest to ancestral aquatic communities
- Lake Superior aquatic foodweb
- Indicator: fish abundance
  - lake trout, chubs, lake herring and whitefish
- Indicator: sea lamprey abundance



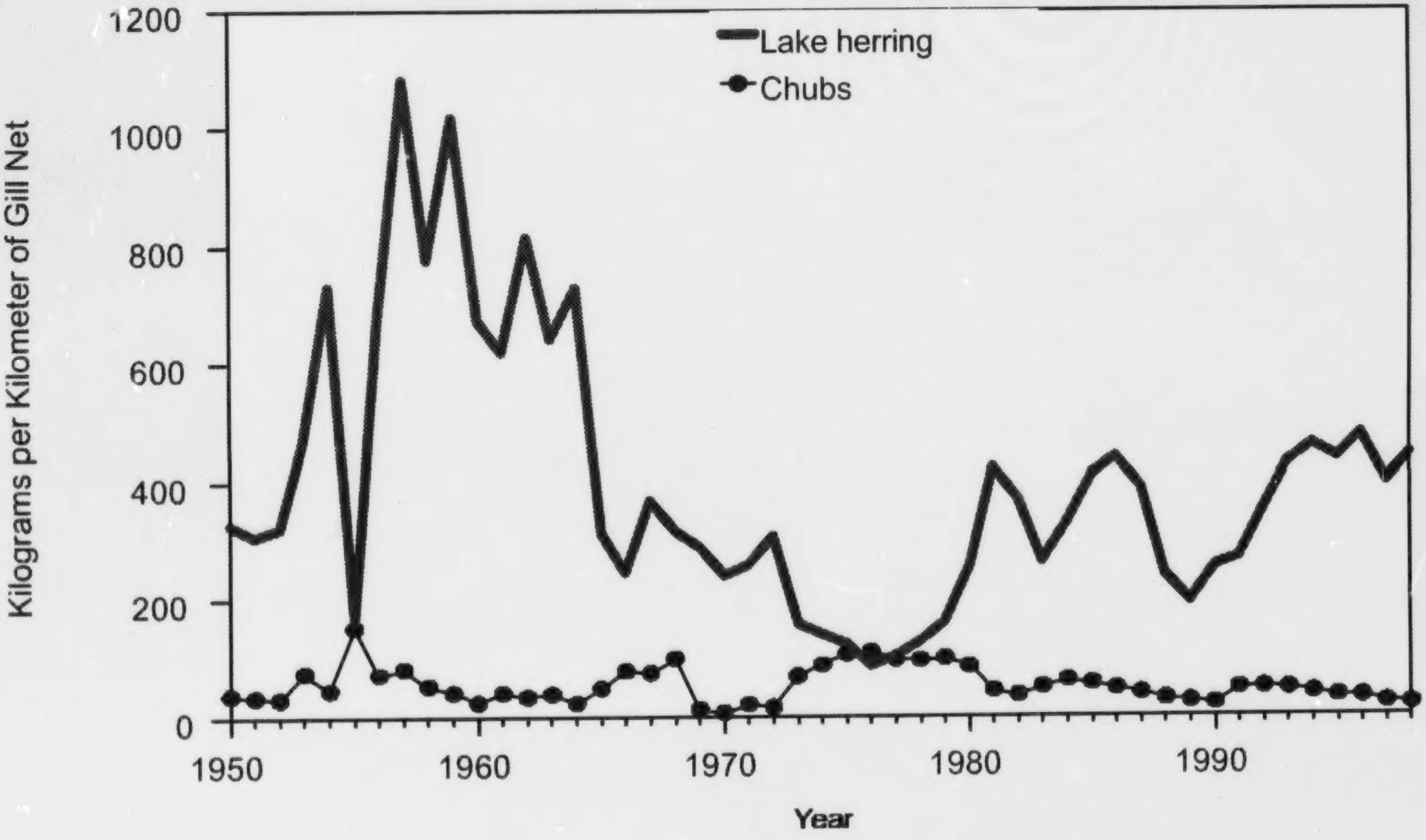
Catch per Unit Effort of Lean and Siscowet Lake Trout in Commercial Fisheries, 1950-1998



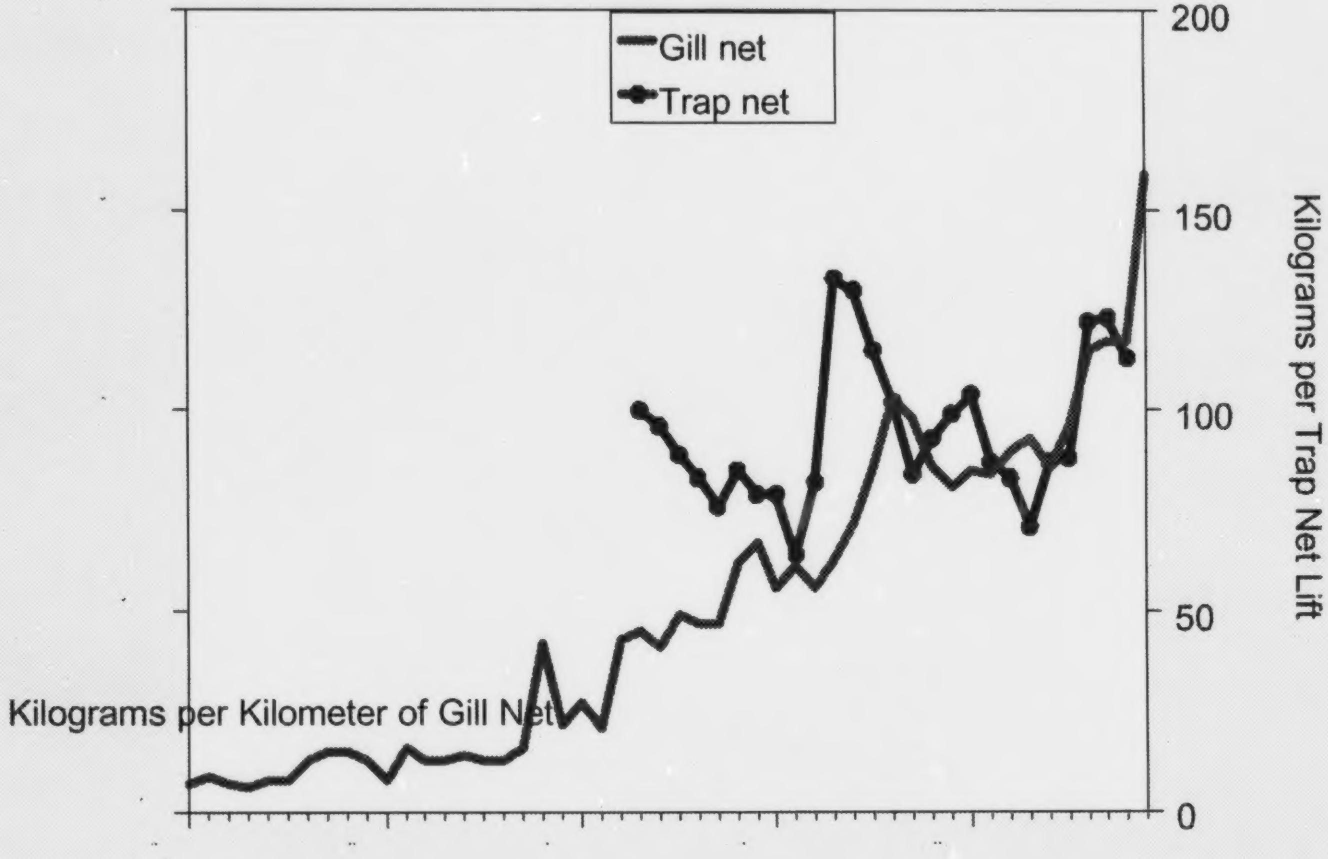
Lean Lake Trout Catch per Unit Effort in Michigan Waters of Lake Superior, 1929-1998



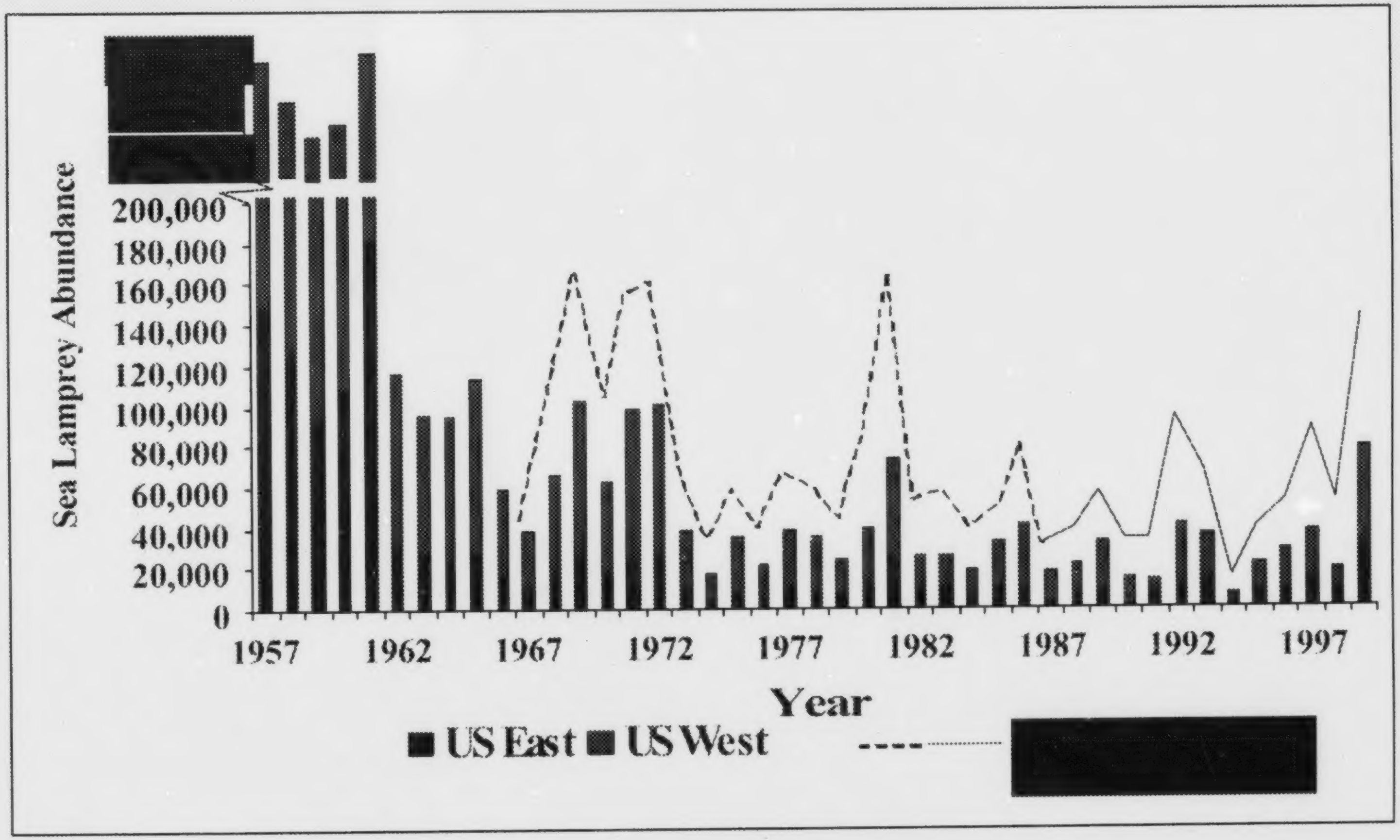
Catch per Unit Effort of Lake Herring and Chubs in Lake Superior Commercial Fisheries, 1950-1998



Catch per Unit Effort of Lake Whitefish in Lake Superior Commercial Fisheries, 1950-1998



Abundance of Sea Lamprey in Lake Superior, 1957-1999



Wildlife Communities

- **Indicator:** forest breeding birds
  - – trend data are unique to the local level
- **Indicator:** colonial waterbirds
  - – herring gulls are indicators of regional contaminant levels

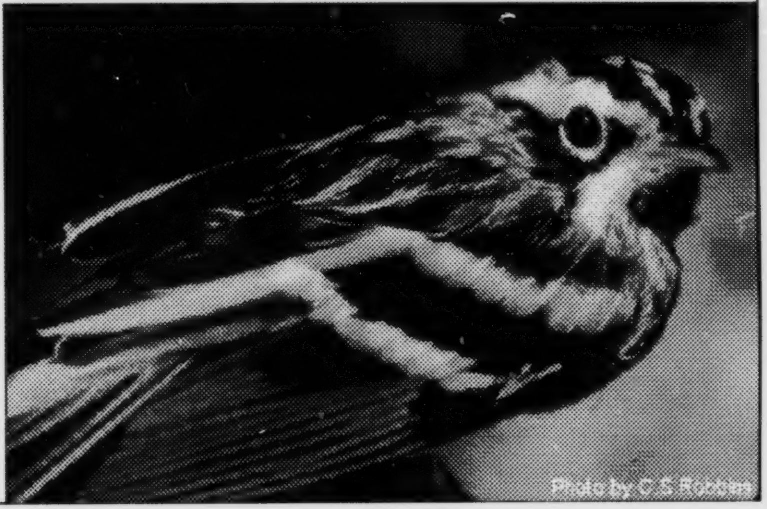
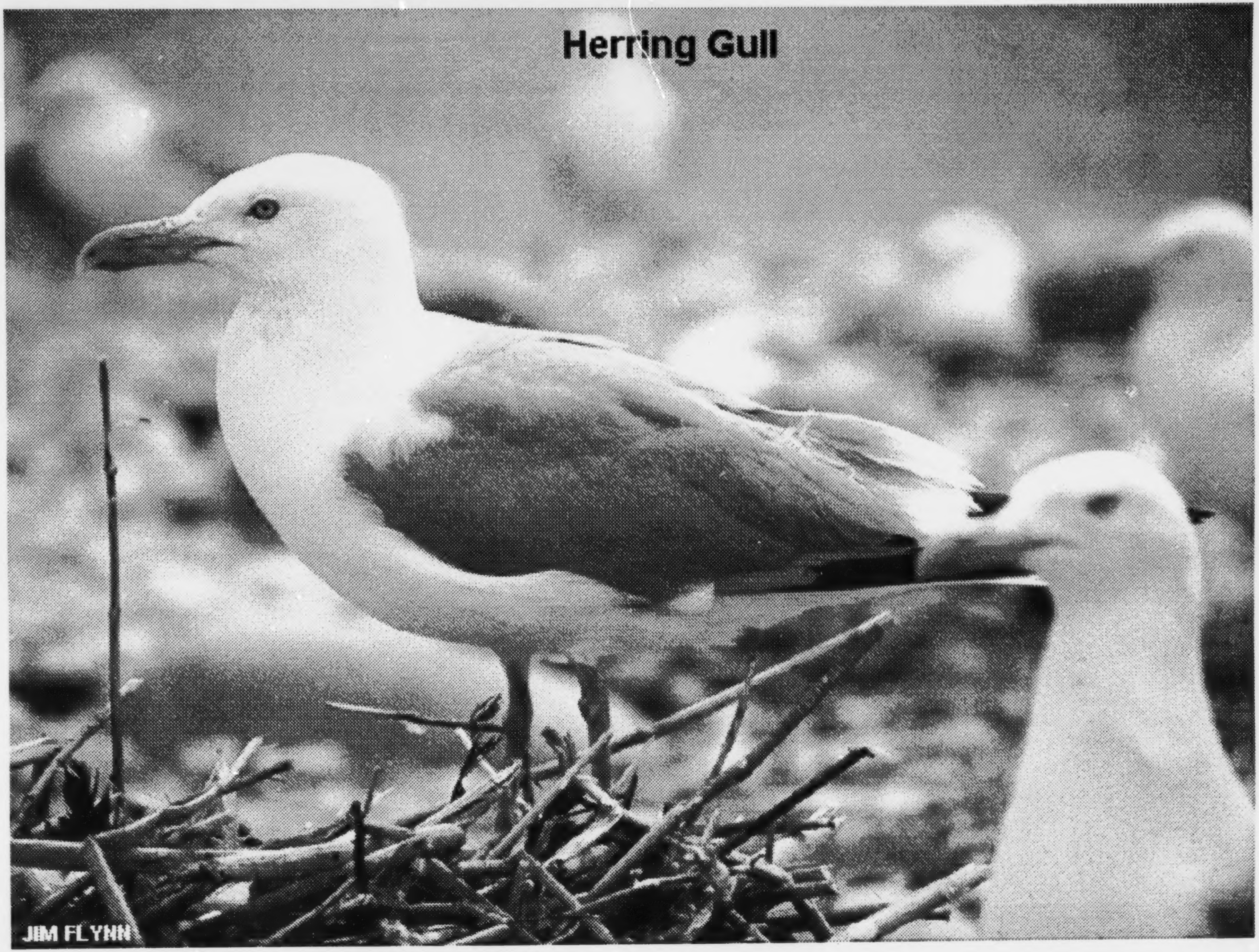


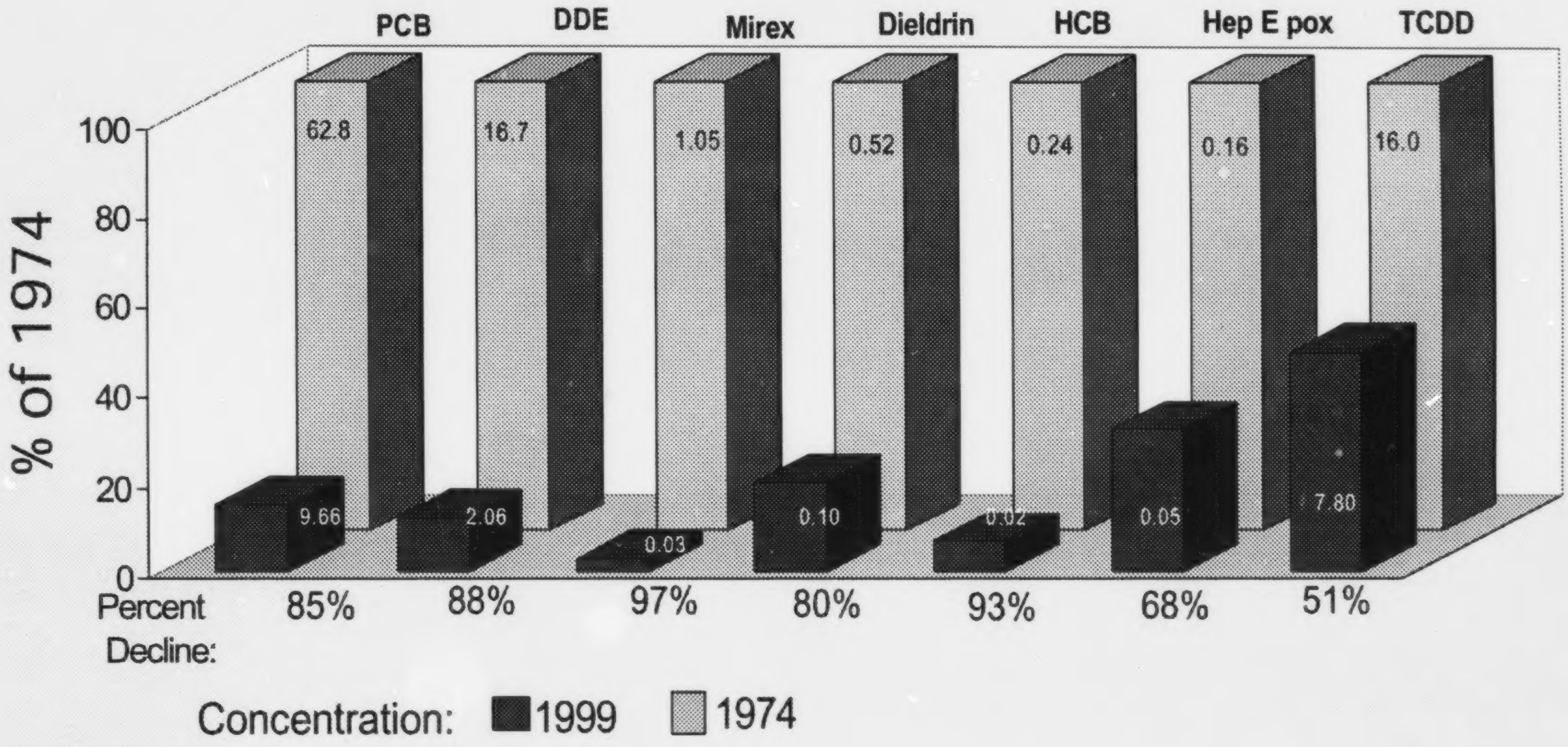
Photo by C.S. Robbins



Herring Gull

JIM FLYNN

Herring Gull Contaminants



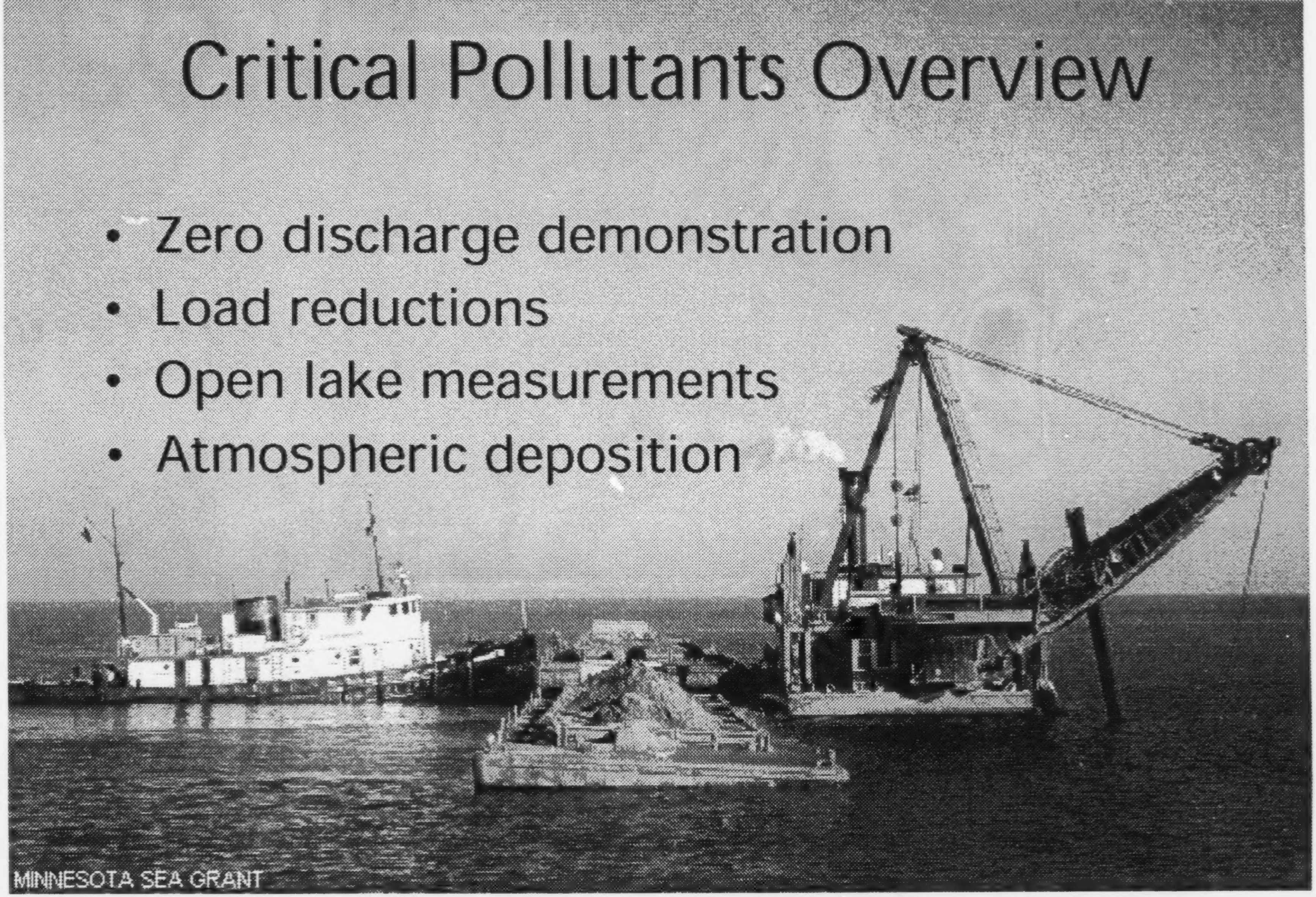
Lake Superior Herring Gull Abundance

	1976-77		1989-90		1999	
	pairs	colonies	pairs	colonies	pairs	colonies
Canada	6,410	149	12,181	299	11,115	301
% change from previous survey			90.0%	100.7%	-8.7%	<1.0 %
U.S.	7,106	90	13,263	187	7,715	134
% change from previous survey			86.6%	107.8%	-41.8%	-28.3%

Canadian data - D.V. Weseloh, personal communication.
U.S. data - J. McKearnan, personal communication,
Cuthbert and McKearnan (1999).

Critical Pollutants Overview

- Zero discharge demonstration
- Load reductions
- Open lake measurements
- Atmospheric deposition

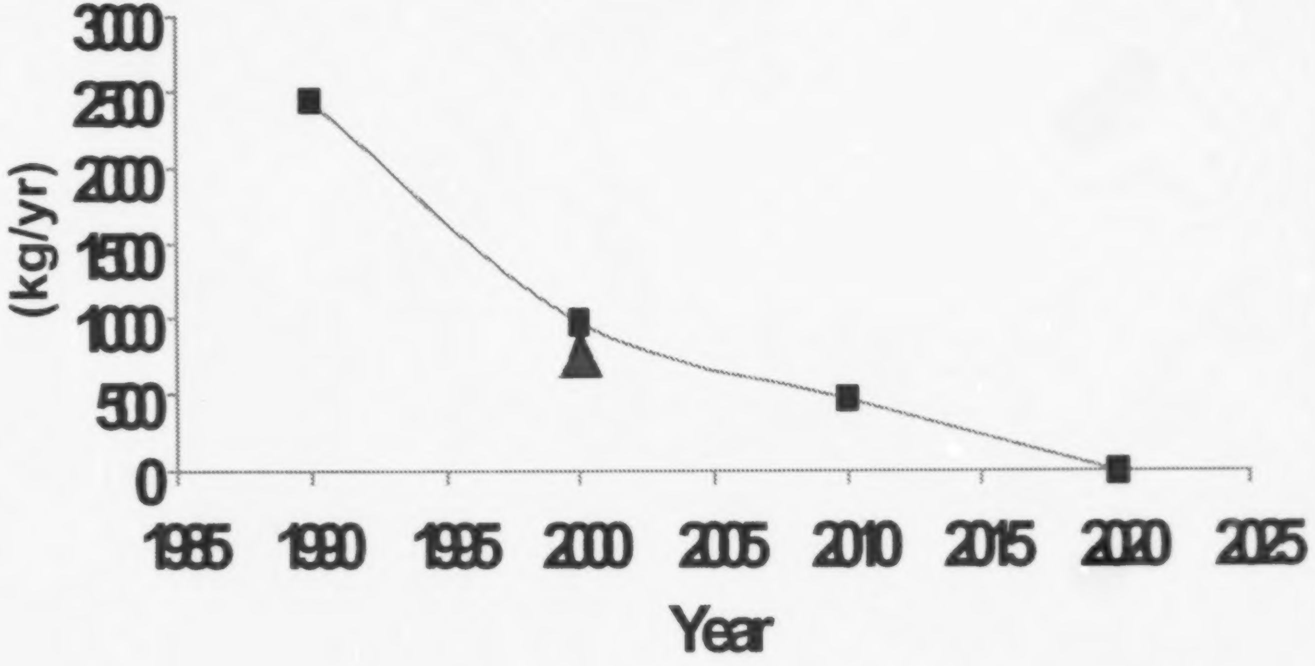


MINNESOTA SEA GRANT

Progress Towards Zero Discharge

- **Management goal:** zero discharge/ emissions of nine critical pollutants
- 2000 mercury goal has been met
- Meeting 2010 milestones requires strategies for fuel combustion and mining

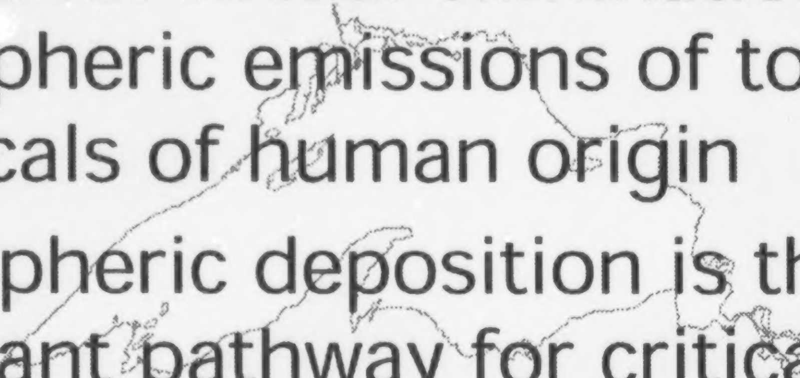
Mercury Reduction from Sources in the Lake Superior Basin



Open Lake Water Concentrations

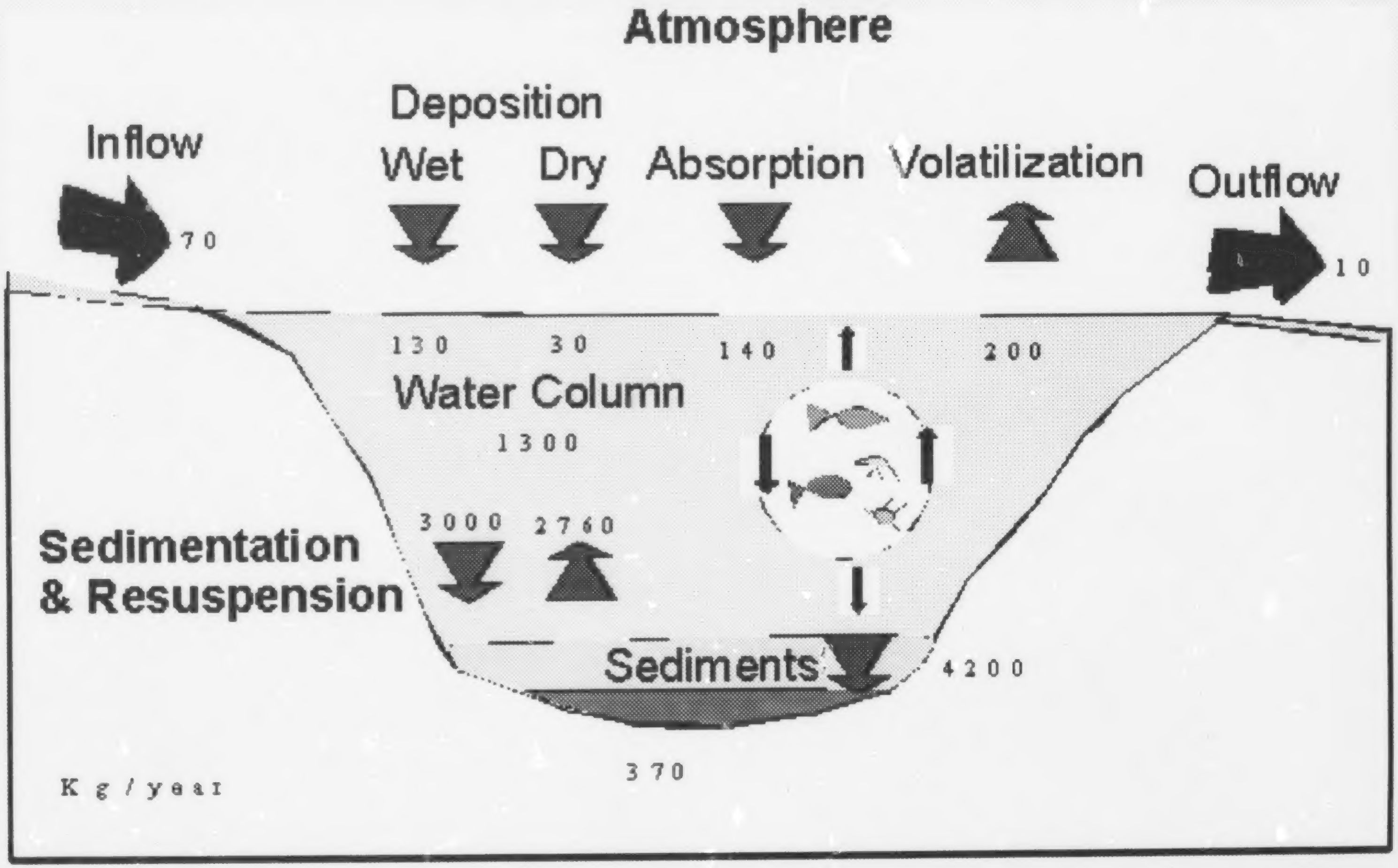
Chemical	Open Lake concentrations (ng/L)	Most sensitive guideline
Chlordane	<0.03; 0.0099	0.012 (WI)
DDT	<0.023	0.011 (WI, MI)
Dieldrin	0.114	0.0012 (MN)
2,3,7,8-TCDD	data not available	0.0000014 (MN)
Hexachlorobenzene	0.012	0.074(MN)
Mercury	0.21 - 1.00	1.3 (MN, MI, WI)
Octachlorostyrene	<0.020	--
PCBs	0.0705	0.003 (WI)
Toxaphene	0.9; 0.7	0.011 (MN)
PAHs, total	0.168	2.8 (EPA)
α-BHC	2.768	3.7 (WI)
Cadmium	data not available	100 (MOE)
Heptachlor + heptachlor epoxide	<0.019+0.052; n/a+0.044	0.1 (MOE)

Atmospheric Deposition

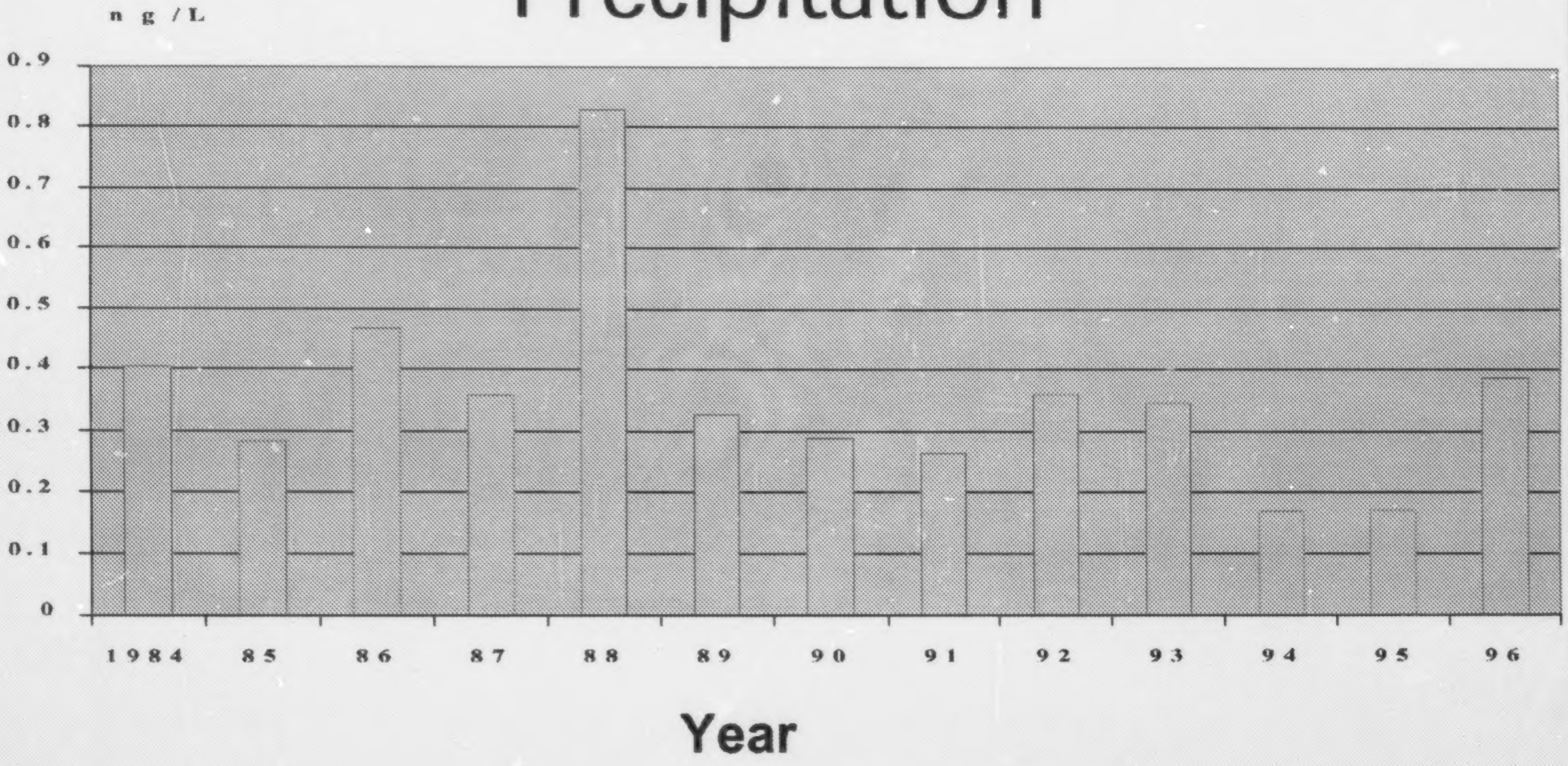


- **Objective:** virtual elimination of atmospheric emissions of toxic chemicals of human origin
- Atmospheric deposition is the dominant pathway for critical pollutants
- Atmospheric loadings will continue for an unknown time

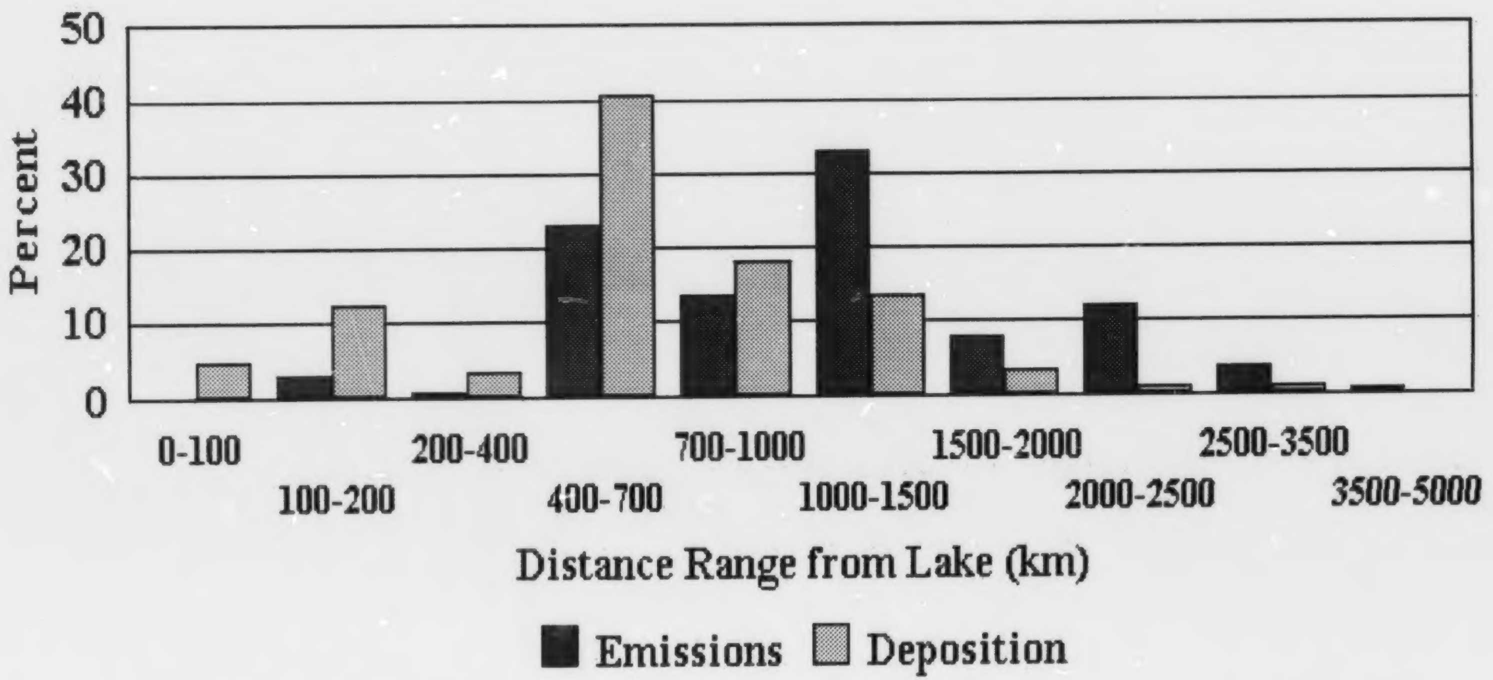
Lake Superior PCB Budget


Atmosphere
Deposition
Inflow
Wet
Dry
Absorption
Volatilization
Outflow
70
10
130
30
140
200
Water Column
1300
3000
2760
Sedimentation
& Resuspension
Sediments
4200
370
Kg/year

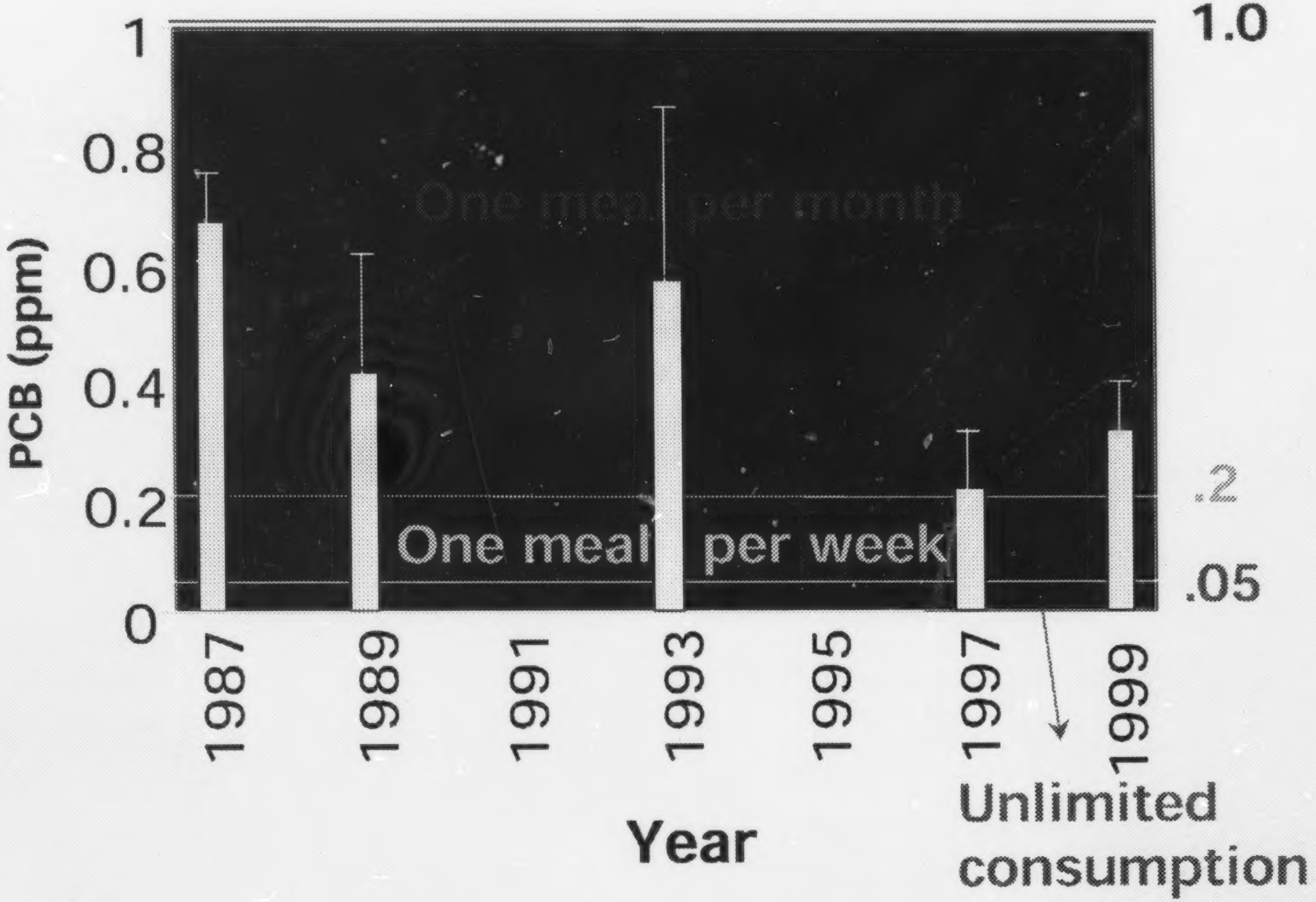
Dieldrin in Lake Superior Precipitation



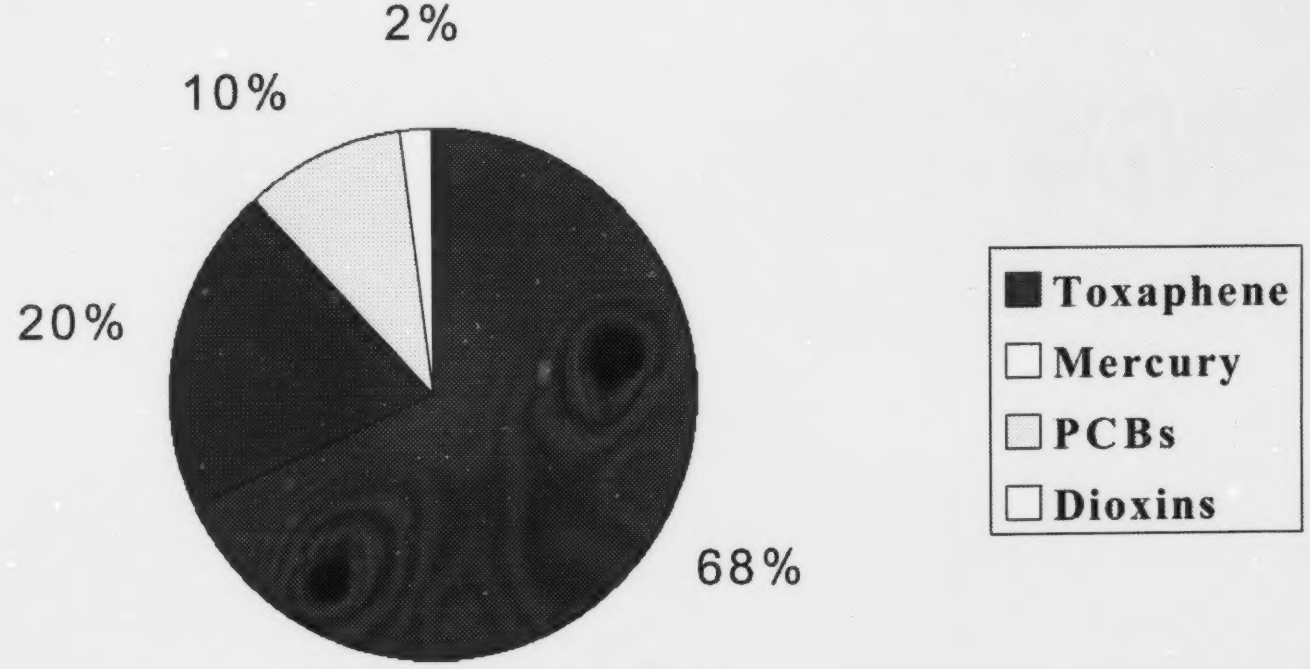
Dioxin Emissions and Deposition within Distance Ranges from Lake Superior, 1996



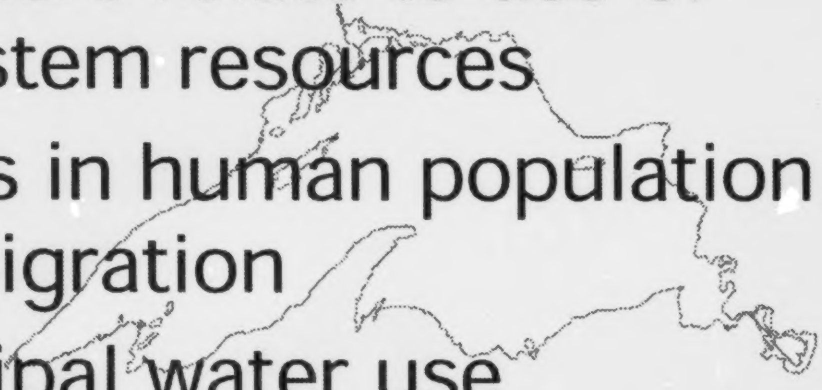
PCBs in Lake Superior Chinook Salmon



Relative Contribution of Contaminants to Ontario Sportfish Advisories

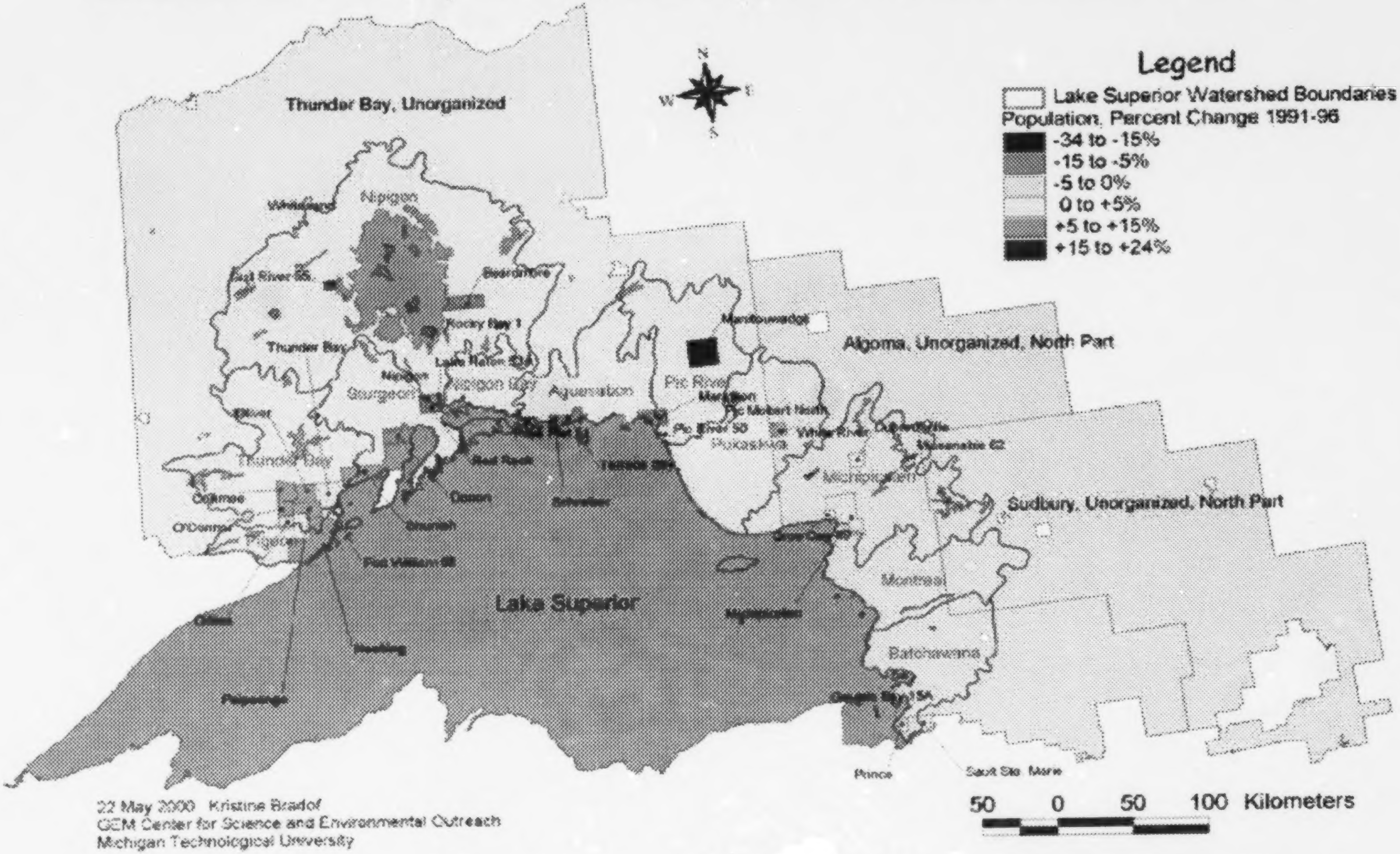


Developing Sustainability



- Indicators relate to use of ecosystem resources
- Trends in human population density and migration
- Municipal water use

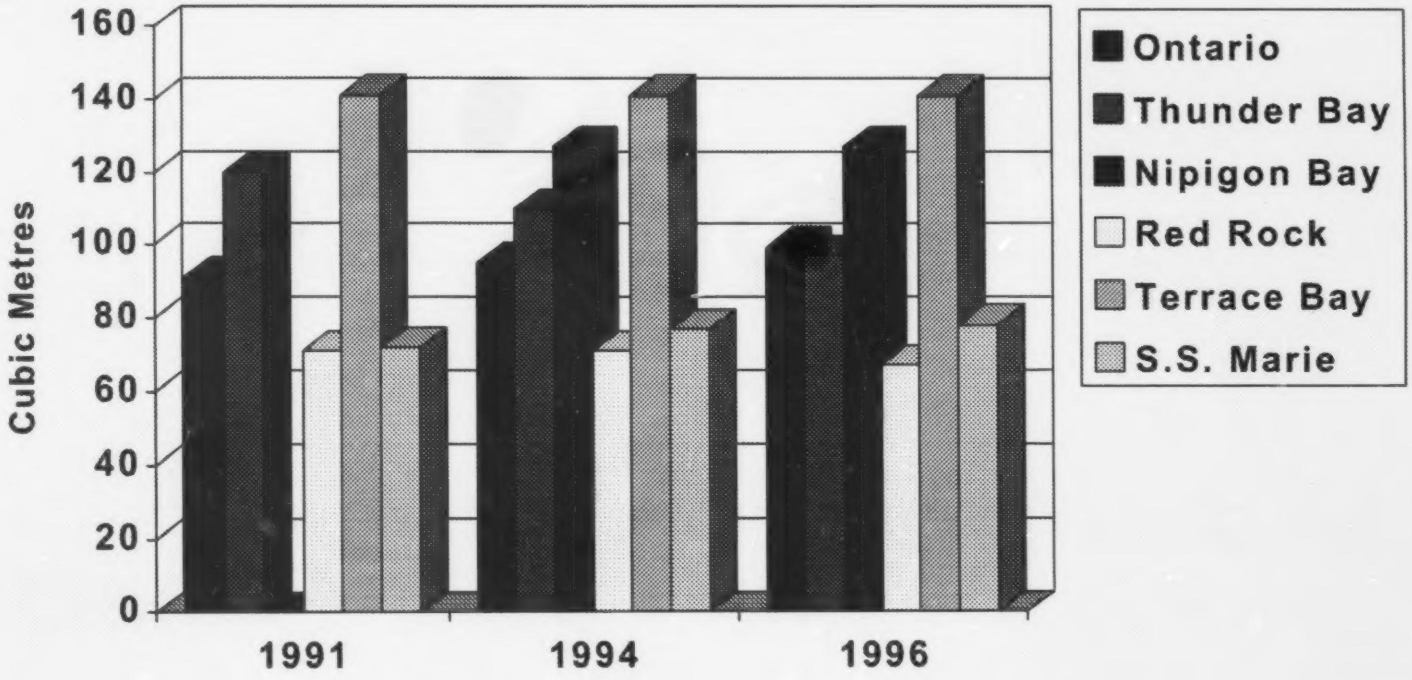
Percent Change in Population, 1991-1996
Ontario Lake Superior Watershed Census Subdivisions


Legend
Lake Superior Watershed Boundaries
Population, Percent Change 1991-96
-34 to -15%
-15 to -5%
-5 to 0%
0 to +5%
+5 to +15%
+15 to +24%
N
W
E
S
Thunder Bay, Unorganized
Nipigon
Red River 55
Beardmore
Rocky Bay 1
Thunder Bay
Lake Helen 53A
Nipigon
Sturgeon
Nipigon Bay
Aguasabon
Pic River
Manitouwadge
Algoma, Unorganized, North Part
Marathon
Pic Mobert North
Pic River 50
White River
Dubreuilville
Pukaskwa
Michipicoten
Missanabie 62
Sudbury, Unorganized, North Part
Thunder Bay
Conmee
O'Connor
Pigeon
Fort William 52
Red Rock
Dorion
Schreiber
Lake Superior
Montreal
Batchawana
Prince
Sault Ste. Marie
50
0
50
100
Kilometers

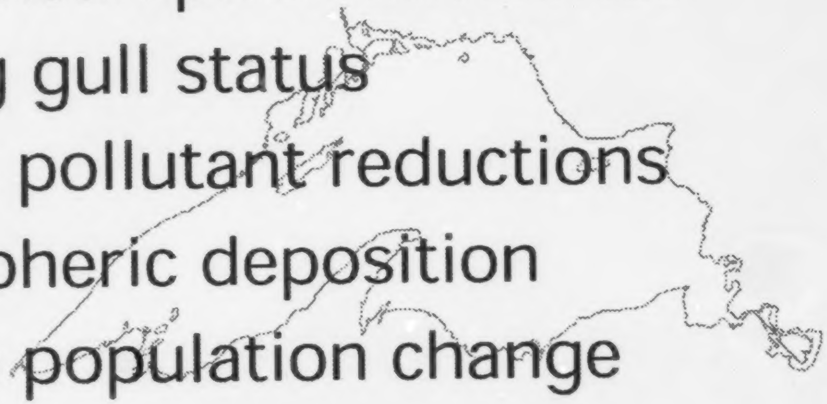
22 May 2000 Kristine Bradof
GEM Center for Science and Environmental Outreach
Michigan Technological University

Data Sources: Statistics Canada 1996 Census Subdivision area profiles for Ontario, Natural Resources Canada watershed boundaries

Annual Per Capita Residential Water Use 1991-1996 (Ontario)

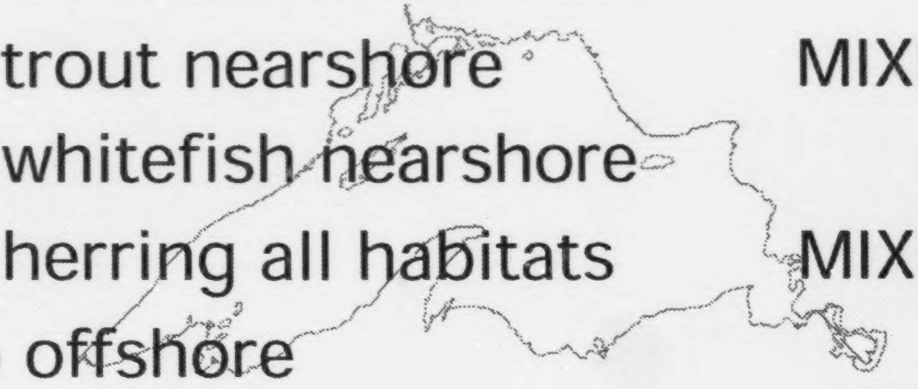


Indicator Summary (1)



• Fish consumption advisories	MIXED
• Herring gull status	MIXED
• Critical pollutant reductions	MIXED
• Atmospheric deposition	MIXED
• Human population change	MIXED
• Water consumption	MIXED

Indicator Summary (2)

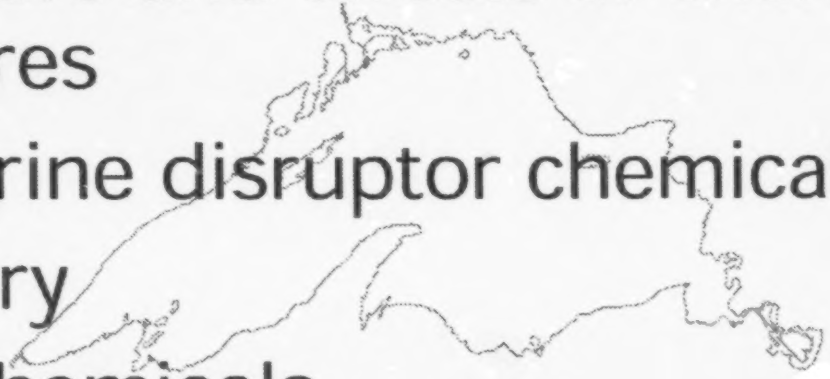


• Lake trout offshore habitat	GOOD
• Lake trout nearshore	MIXED/IMP
• Lake whitefish nearshore	GOOD
• Lake herring all habitats	MIXED/IMP
• Chub offshore	POOR
• Sea lamprey abundance	MIXED/IMP

Emerging Issues (1)

- Introduction of non-native species
- Airborne pollutants
- Human migration into the basin
- Habitat fragmentation
- Meeting zero discharge milestones

Emerging Issues (2)



- Exposure and effects of chemical mixtures
- Endocrine disruptor chemicals
- Mercury
- New chemicals
- Domestic use of burn barrels

Lake Superior Binational Program

- Program announced in 1991 to protect and maintain the ecosystem
- Initial focus on Zero Discharge Demonstration Program
- 1997 six ecosystem themes
- Active public participation (Forum)
- 2000-2002 project implementation

Acknowledgements

- Aquatic communities: Mark Ebener Inter Tribal Fisheries and Assessment Program
- Terrestrial wildlife communities: Pam Dryer U.S. Fish and Wildlife Service
- Habitat: Pat Collins Minnesota DNR
- Chemicals: Melanie Neilson Environment Canada Carri Lohse-Hanson Minnesota PCA
- Human Health: Pat McCann Minnesota Department of Public Health
- Sustainability: Jim Cantrill Northern Michigan University, Karl Schaefer Environment Canada

STATE OF THE LAKE
LAKE MICHIGAN
FISHERIES

Thomas Trudeau
Illinois Department of Natural Resources

A Joint Strategic Plan
for
Management
of
Great Lakes Fisheries

COTFMA

GLIFWC

Illinois

Ontario

Pennsylvania

Ohio

Indiana

Michigan

Great Lakes Fishery Commission

Minnesota

New York

Wisconsin

Changes in Lake Michigan fishery

Pre-1900
Major Predators
lake trout
burbot
Planktivores
7 species ciscoes
2 species whitefish
lake herring
emerald shiners
Benthivores
lake sturgeon
4 species sculpin
suckers

Post-1970
Major Predators
lake trout, burbot, coho
chinook, rainbow t, brown t
Planktivores
1 species ciscoes
2 species of whitefish
smelt, alewife
Benthivores
suckers
2 species sculpin
carp

Non-native species in red

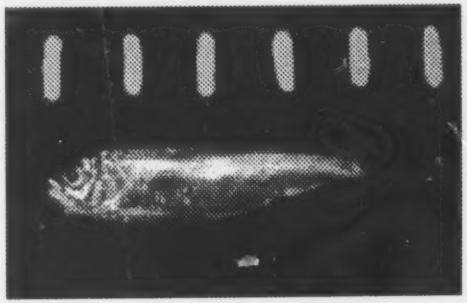
Goal for Lake Michigan Fish Community Objectives

- To restore and maintain the biological integrity of the fish community so that production of desirable fish is sustainable and ecologically efficient

The State of Lake Michigan Planktivores

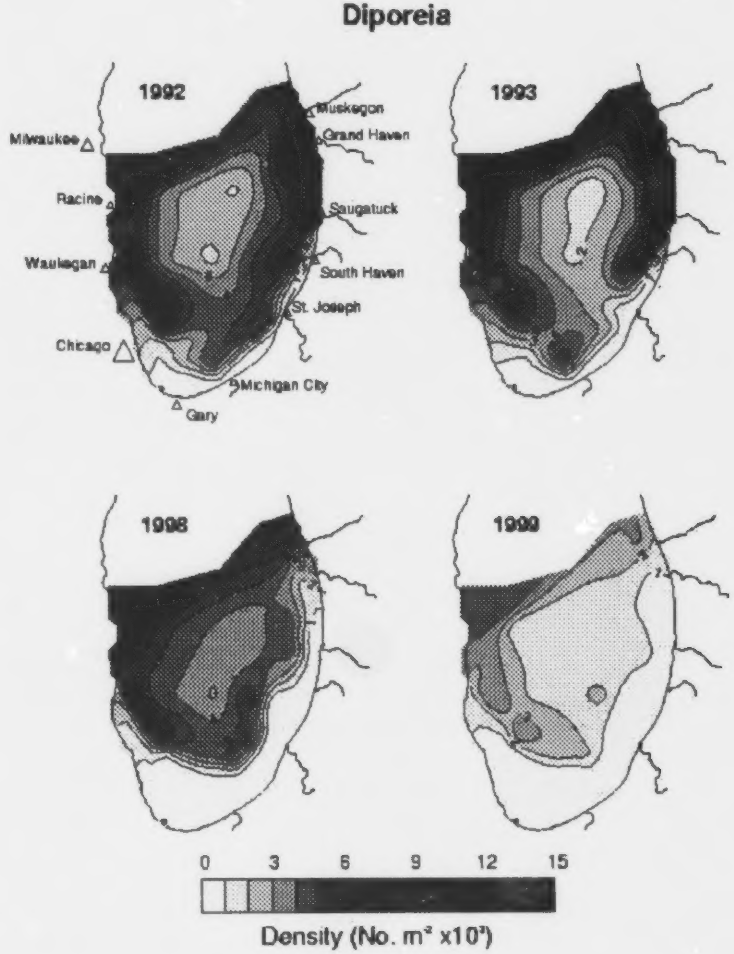
by Guy Fleischer (USGS)

Maintain a diversity of planktivore (prey fish) species at population levels matched to primary production and to predator demands. Expectations are for a lakewide planktivore biomass of 0.5 to 0.8 billion kg (1.2 to 1.7 billion lb).

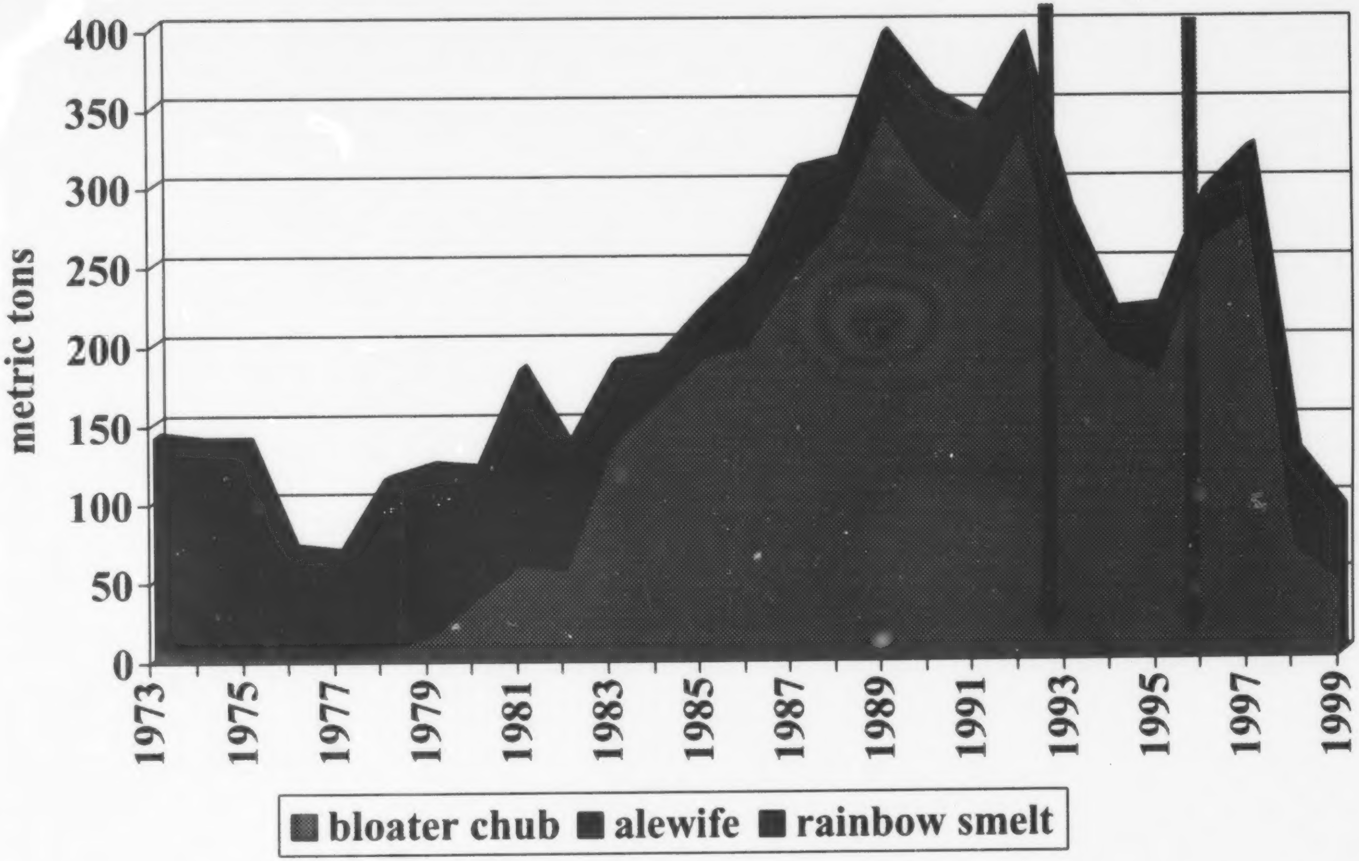


Monitoring: *Diporeia* Decline

Routine monitoring of the abundance of benthic amphipods at 40 sites in Lake Michigan's southern basin has shown a decline in bottom life. While the exact cause of the decline is unknown, GLERL scientists suspect it is linked to the introduction of zebra mussels. The dominant amphipods, *Diporeia spp.*, are eaten by a variety of Great Lakes fish and are an important component of the Lake Michigan food web.

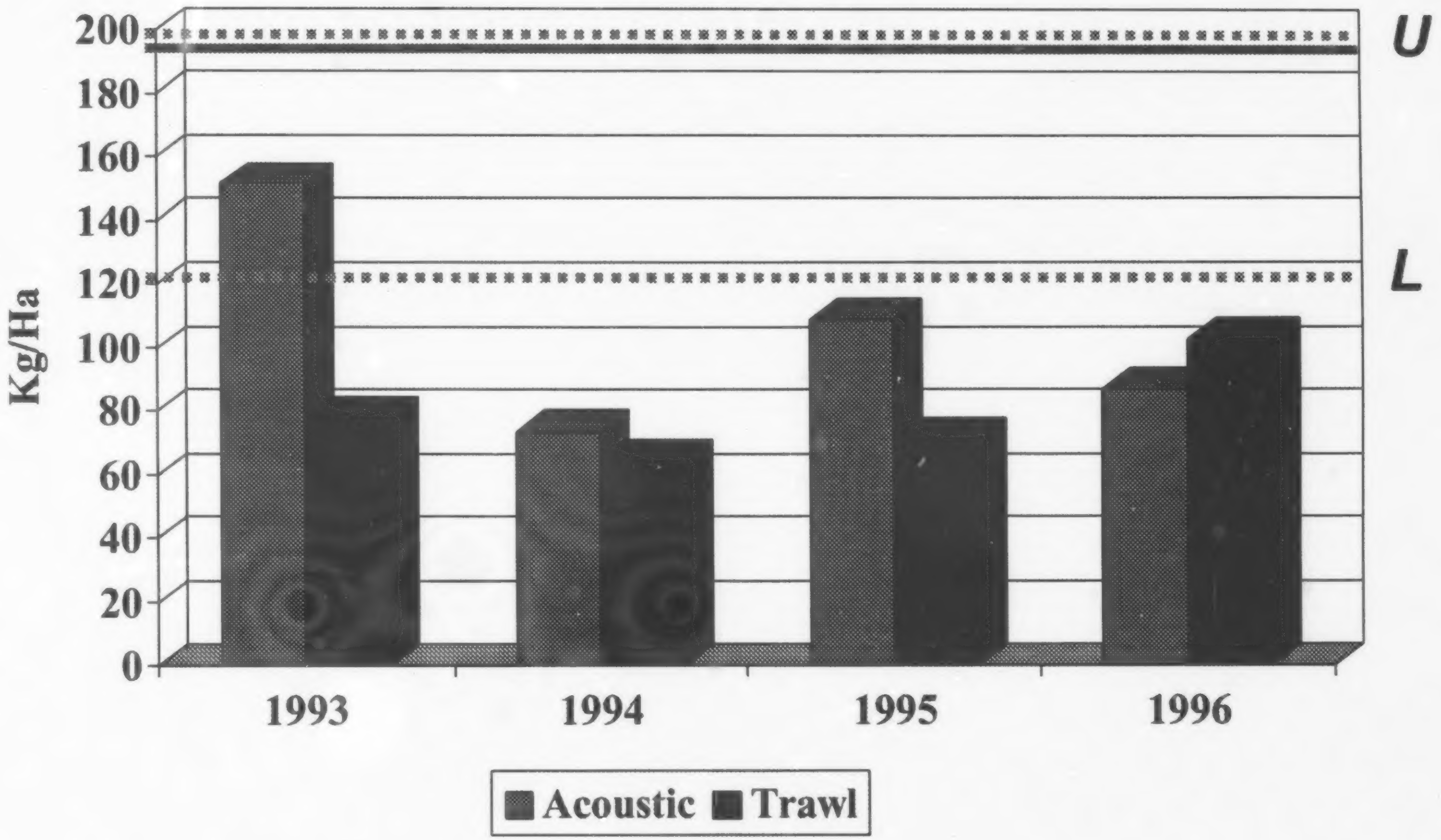

Diporeia
1992
1993
1998
1999
Milwaukee
Racine
Waukegan
Chicago
Gary
Michigan City
St. Joseph
South Haven
Saugatuck
Grand Haven
Muskegon
0
3
6
9
12
15
Density (No. m^2 x10^3)

Lake Michigan Forage Fish Estimate



From annual USGS Bottom Trawl Assessment

Lake Michigan Forage Fish Estimate

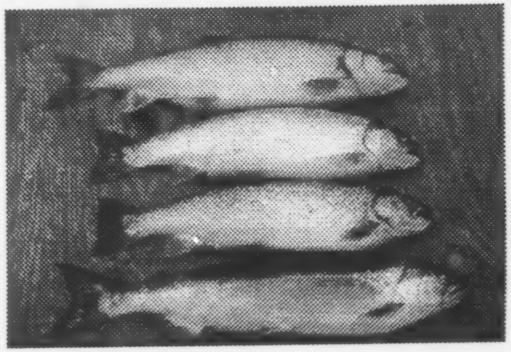


The State of Lake Michigan Salmonines

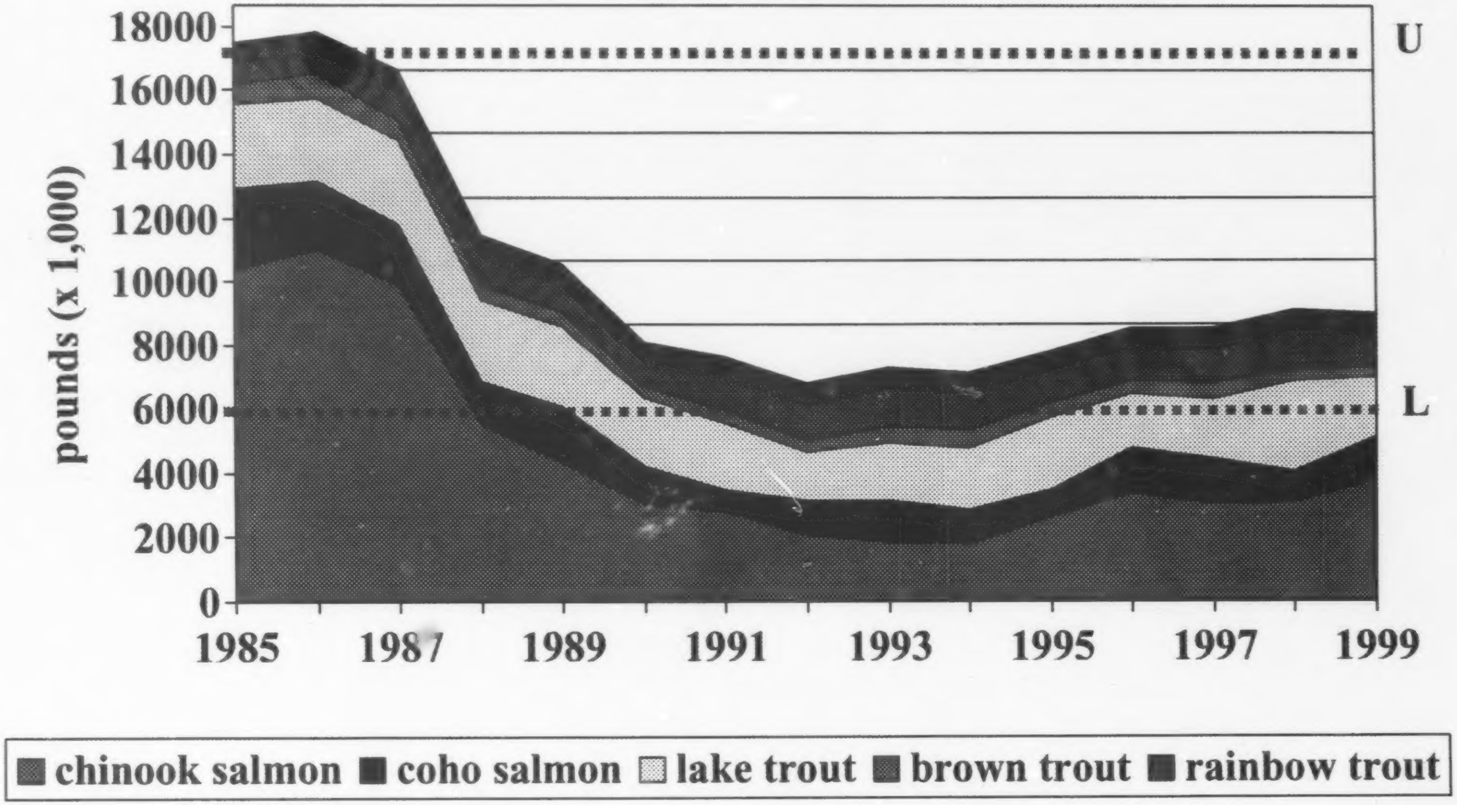
by Jory Jonas (MnDNR)

Establish a diverse salmonine community capable of sustaining an annual harvest of 2.7 to 6.8 million kg (6 to 15 million lb), of which 20-25% is lake trout.

Establish self-sustaining lake trout populations.



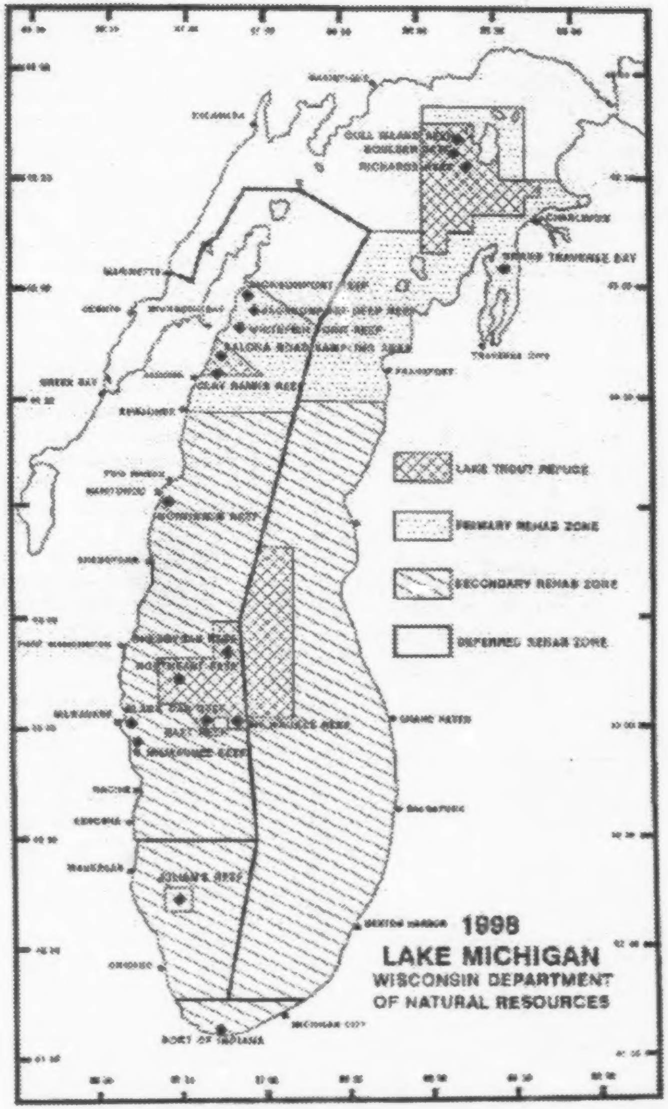
Lakewide Trout and Salmon Harvest



Lake Trout Rehabilitation Plan
1985

Achieve self-sustaining lake trout populations capable of sustaining an annual harvest of 1,100 t through:

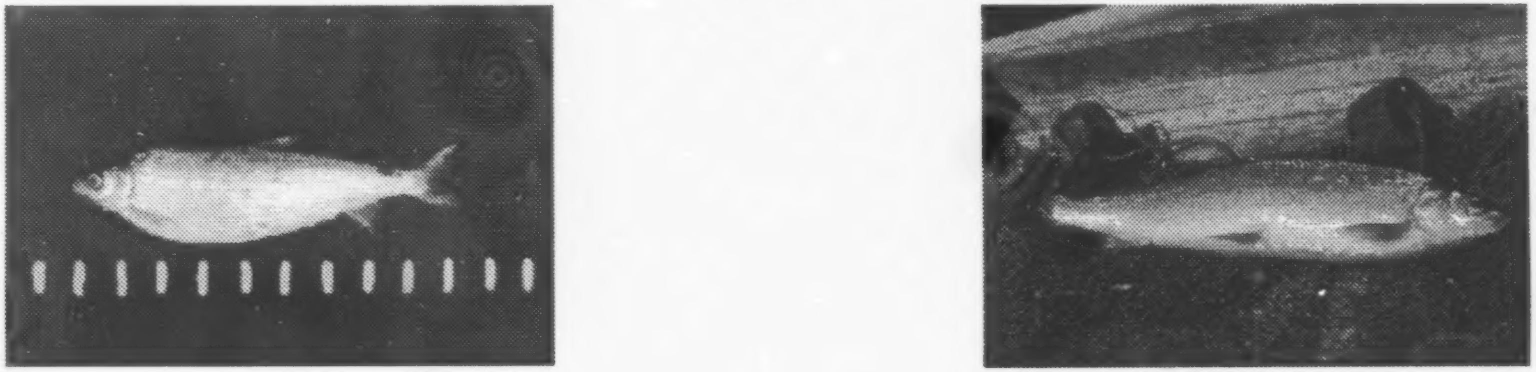
- ♦establishment of rehabilitation zones based upon quality of spawning habitat
- ♦a total mortality cap not to exceed 40%
- ♦specific prioritized stocking rates by zones
- ♦evaluation of different strains


GULL ISLAND REEF
BOULDER REEF
RICHARDS REEF
CHARLEVOIX
GRAND TRAVERSE BAY
MARINETTE
GREEN BAY
FRANKFORT
CLAY BANKS REEF
GRAND HAVEN
PORT OF INDIANA
▨ LAKE TROUT REFUGE
▨ PRIMARY REHAB ZONE
▨ SECONDARY REHAB ZONE
☐ DEFERRED REHAB ZONE
1998
LAKE MICHIGAN
WISCONSIN DEPARTMENT OF NATURAL RESOURCES

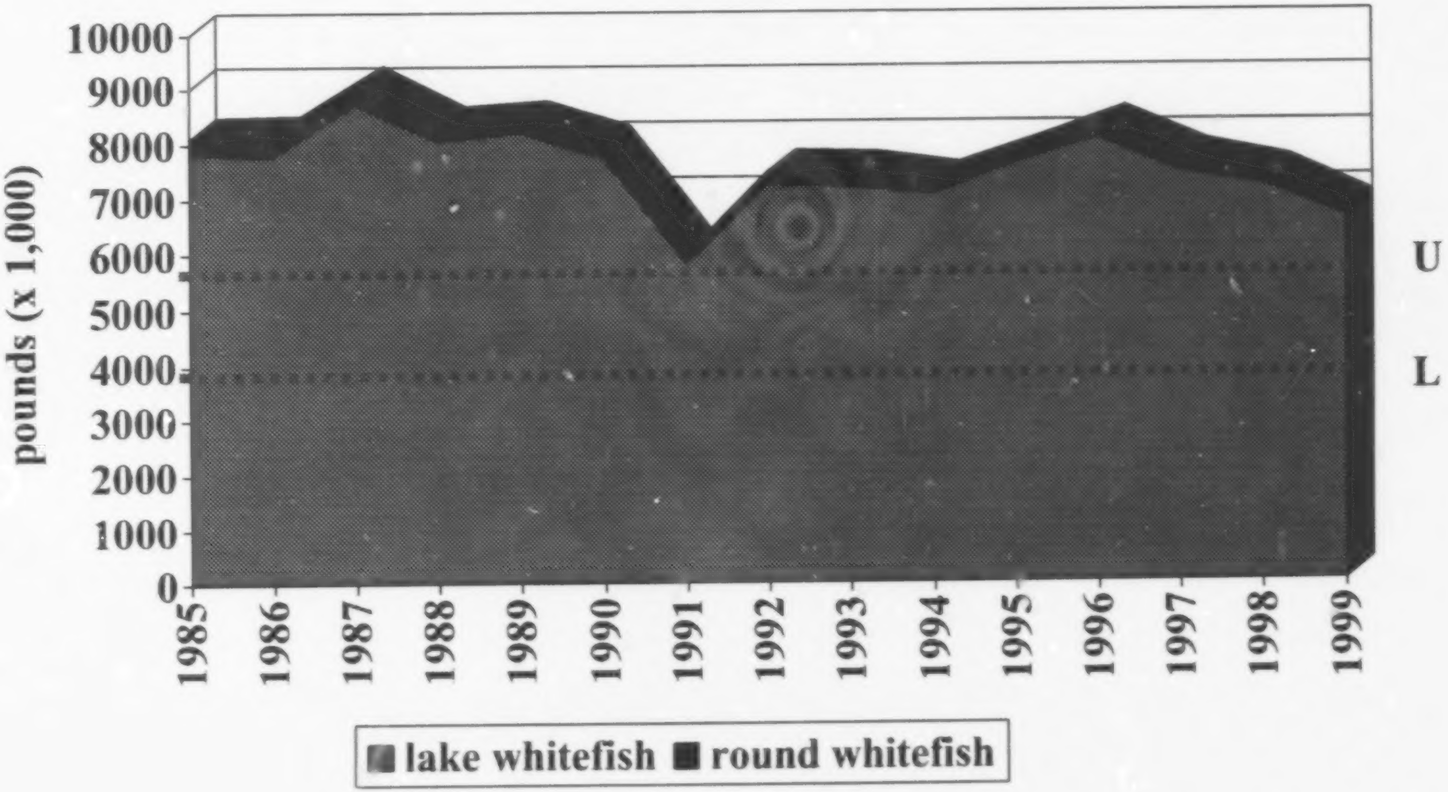
The State of Lake Michigan Benthivores - Coregonids

by Phil Schneeberger

Maintain self-sustaining stocks of lake whitefish, round whitefish, sturgeon, suckers, and burbot. The expected annual yield of lake whitefish should be 1.8-2.7 million kg (4 to 6 million lb).



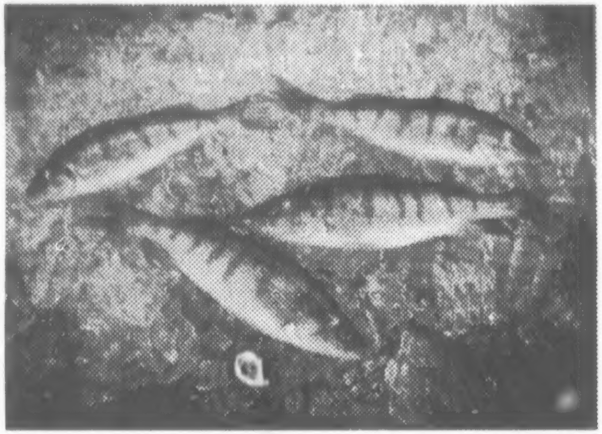
Lakewide Coregonid Harvest



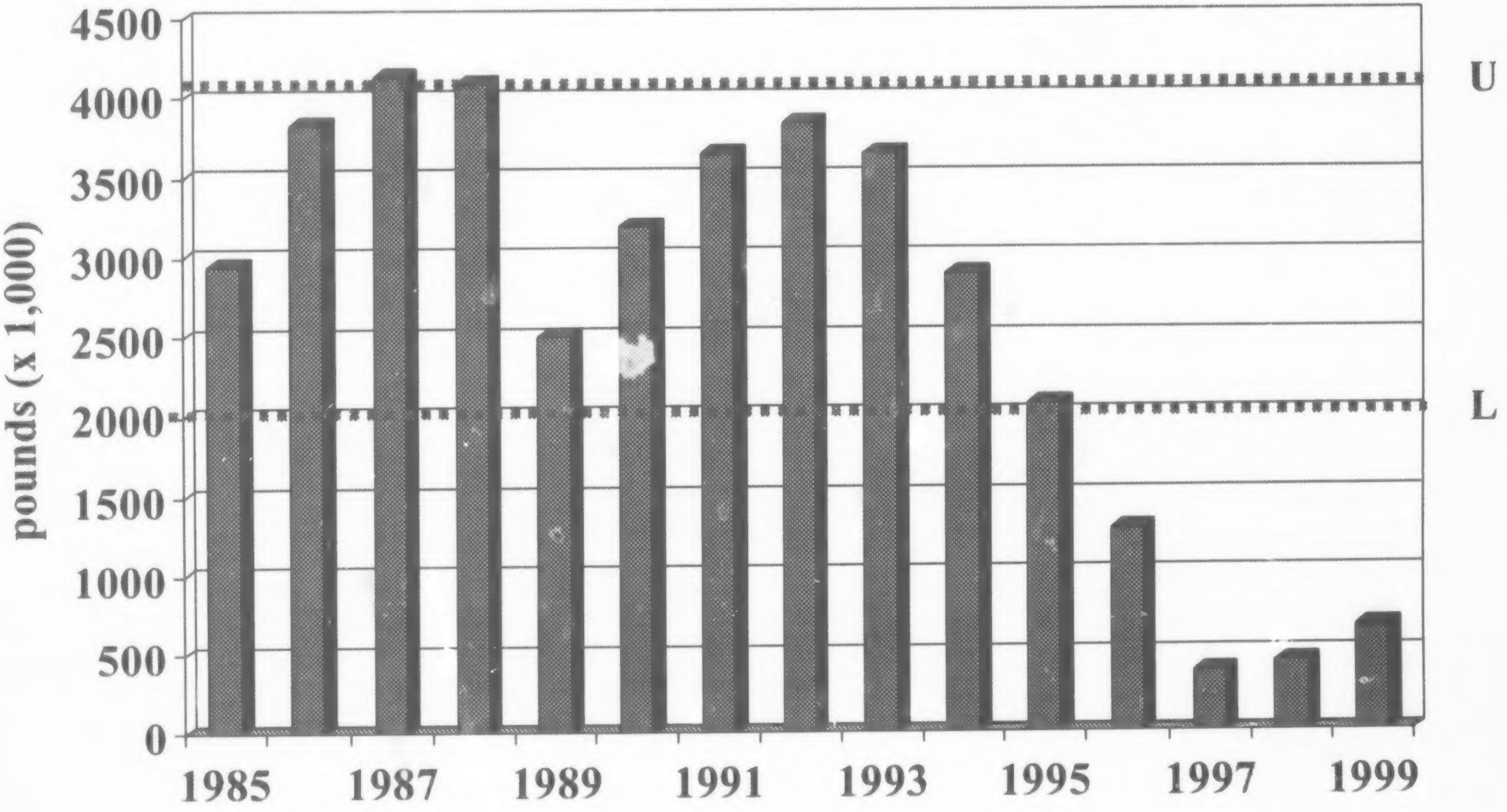
The State of Lake Michigan Inshore Fish Stocks

by Dave Clapp (MnDNR)

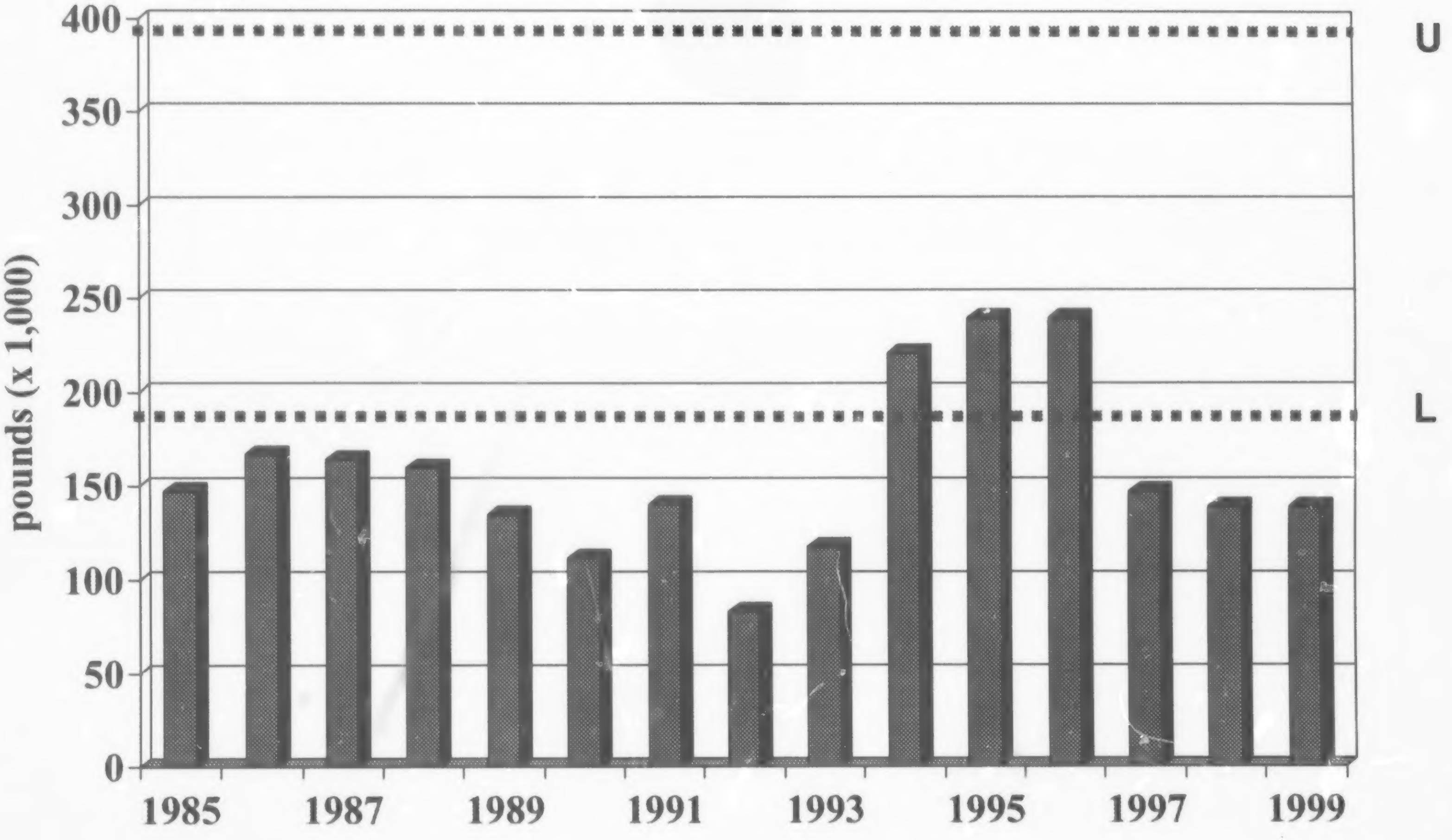
Maintain self-sustaining stocks of yellow perch, walleye, smallmouth bass, pike, catfish, and panfish. Expected annual yields should be 0.9 to 1.8 million kg (2 to 4 million lb) for yellow perch and 0.1-0.2 million kg (0.2 to 0.4 million lb) for walleye.



Lakewide Yellow Perch Harvest



Lakewide Walleye Harvest



The State of Lake Michigan Physical/Chemical Habitat

by Mark Holey (USFWS)

Protect and enhance fish habitat and rehabilitate degraded habitats.

Achieve no net loss of the productive capacity of habitat supporting Lake Michigan's fish communities. High priority should be given to the restoration and enhancement of historic riverine spawning and nursery areas for anadromous species.

- Remedial Action Plans (RAPs) are in various stages of remediation for the ten AOCs.
- River flow management through Hydroelectric facilities
- No Net Fish Habitat Loss
- Lake Michigan Mass Balance Project
- Lakewide Management Plan (LaMP)

Fish Community Objectives

- ## Other Species Objective

  Protect and sustain a diverse community of native species, including other species not specifically mentioned earlier (for example, cyprinids, gars Lepisosteus spp., bowfin (Amia calva), brook trout, and sculpins). These species contribute to the biological integrity of the fish community and should be recognized and protected for their ecological significance and cultural and economic values.

- ## Sea Lamprey Objective

  Suppress the sea lamprey to allow the achievement of other fish-community objectives.

Progress Toward Achievement of Fish Community Objectives

Objectives	*Grade*
Fish Population Structures	Mixed/Improving
Restoration/Protection Of Fish Habitat	Mixed/Deteriorating
Prevention/Control of Aquatic Nuisance Species	Mixed